Lang Creek Beach Fishery 2008/2009: Creel Survey Catch and Effort Estimates

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by

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TABLE OF CONTENTS

TABLE OF CONTENTS iii
LIST OF TABLES iv
LIST OF FIGURES vi
ABSTRACT viii
RÉSUMÉ ix
INTRODUCTION 1
Background 1
Study Area 2
METHODS 2
Effort Counts 3
Angler Interviews 3
Analysis 4
Beach-based Anglers 4
Boat-based Anglers 5
Within and Between Year Comparisons 6
Biological Sampling and Supplementary Data 6
RESULTS 6
2008 6
Effort 6
Catch Rate 7
Estimated Catch 7
Biological Sampling 8
Supplementary data 8
2009 9
Effort 9
Catch Rate 9
Estimated Catch 10
Biological sampling 11
Supplementary data 11
Between Year Comparisons 12
Effort 12
Catch Rates 12
Estimated Catch 13
Supplementary data 13
DISCUSSION 14
Effort 14
Catch Rates and Total Catch 15
Supplementary data 17
Overall Discussion, Future Recommendations and Conclusion 17
ACKNOWLEDGEMENTS 21
REFERENCES 22

LIST OF TABLES

Table 1: 2008 Catch rates for beach-based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....24

Table 2: 2008 Catch rates for boat-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....24

Table 3: 2008 Estimated total catch for beach-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....25

Table 4: 2008 Total estimated catch for beach-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho).....25

Table 5: 2008 Estimated total catch for boat-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....25

Table 6: 2008 Total estimated catch for boat-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho).....25

Table 7: 2009 Catch rates for land based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....26

Table 8: 2009 Catch rates for beach-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....26

Table 9: 2009 Estimated total catch for beach-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....27

Table 10: 2009 Total estimated catch for beach-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho).....27

Table 11: 2009 Estimated total catch for boat-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....27

Table 12: 2009 Total estimated catch for boat-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho).....27

Table 13: 2008 and 2009 Comparison of catch rates for beach-based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....28

Table 14: 2008 and 2009 Comparison of catch rates for boat-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....28

Table 15: 2008 and 2009 Comparison of estimated total catch for beach-based anglers by year and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....29

Table 16: 2008 and 2009 Comparison of total estimated catch for beach-based anglers by year for each species kept and released (and by adipose status for Chinook and Coho).....29

Table 17: 2008 and 2009 Comparison of estimated total catch for boat-based anglers by year and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho).....29

Table 18: 2008 and 2009 Comparison of total estimated catch for boat-based anglers by year for each species kept and released (and by adipose status for Chinook and Coho).....29

LIST OF FIGURES

Figure 1: Map of study area (obtained from Google Earth™ on January 7, 2009)..... 30

Figure 2: Average daily effort profile for beach-based anglers by stratum in 2008..... 31

Figure 3: Average daily effort profile for boat-based anglers by stratum in 2008 31

Figure 4: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008..... 32

Figure 5: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type in 2008..... 32

Figure 6: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout for the 2008 survey period..... 33

Figure 7: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout for the 2008 survey period..... 33

Figure 8: Average daily effort profile for beach-based anglers by stratum in 2009..... 34

Figure 9: Average daily effort profile for boat-based anglers by stratum in 2009 34

Figure 10: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2009..... 35

Figure 11: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type in 2009..... 35

Figure 12: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho, sea-run Cutthroat Trout, Pink and Chum for the 2009 survey period..... 36

Figure 13: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and Pink salmon for the 2009 survey period..... 36

Figure 14: Average daily effort profile for beach-based anglers by stratum for 2008 and 2009 comparison..... 37

Figure 15: Average daily effort profile for boat-based anglers by stratum for 2008 and 2009 comparison..... 37

Figure 16: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008 and 2009 comparison 38

Figure 17: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008 and 2009 comparison..... 38

Figure 18: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho, sea-run Cutthroat Trout, Pink and Chum for the 2008 and 2009 survey period comparison 39

Figure 19: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout and Pink for the 2008 and 2009 survey period comparison 39

Figure 20: Residency of anglers fishing on the Lang Creek beach fishery during the 2008 survey period (n=308) where "ni" stands for "not including" 40

Figure 21: Residency of anglers fishing on the Lang Creek beach fishery during the 2009 survey period (n=562) where "ni" stands for "not including" 40

Figure 22: Regional residency within BC of anglers fishing at the Lang Creek beach fishery during the 2009 survey period (n=544) 41

Figure 23: Percent of total of each type of angler gear (left) and fishing method (right) in the Lang Creek beach fishery for the 2008 survey period (n=308) 41

Figure 24: Percent of total of each type of angler gear (left) and fishing method (right) in the Lang Creek beach fishery for the 2009 survey period (n=570) 41

Figure 25: Lang Creek salmon escapement totals for 2008 and 2009 and previous five year averages (2003 – 2007 average)..... 42

ABSTRACT

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Recreational catch and effort estimates are determined through creel survey angler interviews and effort counts over a defined period for a specific fishery and can be used to determine the condition of fish stocks and the objectives for fish management. Creel surveys were conducted at the Lang Creek beach fishery in 2008 from August 17 to October 18 and in 2009 from August 1 to September 30, with a total of 40 survey days per year. Roving effort counts were preformed every hour during each seven hour survey day where all beach-based anglers were counted as well as the number of boats fishing. Angler interview data included incomplete trip information for intercepted beach-based anglers (roving survey) and complete trip information for returning boating anglers (access survey). The data were used to determine the average daily effort, total effort, catch rates and estimated total catch for beach-based and boating anglers, by species and day type. The data were compared for differences in effort and catch for each fishing type (beach-based and boat) within each year and between years.

In 2008, effort was highest during the first half of the survey period and during this time boating anglers were the most active and had higher effort than beach based anglers. In 2009, effort switched to predominately a beach fishery with little boating effort. Boating anglers were more active in the mornings and evenings and beach-based angler activity varied throughout the day. Catch rates and estimated total catch in 2008 for Chinook and Coho diminished over time, were variable for sea-run coastal Cutthroat Trout and were higher for boating anglers. Catch rates and total catch were generally higher and more consistent in 2009 and anglers caught two additional species compared to the previous year (Pink and Chum salmon). Residency, gear type and methods for interviewed anglers were compared and were similar for both years.

Angler effort and catch rates were likely affected by weather, tides, fish abundance and migration timing. Catch rates were generally higher during 2009 which was reflected by the higher adult returns into Lang Creek compared to 2008. The fishery is a mark selective fishery and a bag limit is in place, which may have negatively affected beach based anglers catch that were intercepted during their fishing trips ("length-of-stay" bias). Recommendations for future roving creel surveys at the Lang beach fishery include a boat-based method for effort counts and interviews for boating anglers for a true roving survey or exploring alternate sampling methods such as a mail in survey. Angler interview information should also include angler experience level for the purpose of determining difference in catch rates between novice and experienced anglers. It may be useful to host an information session for the local public on the creel survey results, future data collection methods and the importance of sustainable management and conservation of the Lang Creek beach fishery.

RÉSUMÉ

Watson, N.M. 2011. Lang Creek beach fishery 2008/2009: Creel survey catch and effort estimates. Can. Manuscr. Rep. Fish. Aquat. Sci. 2889: ix + 44 p.

Les estimations des prises et de l'effort liés à la pêche récréative sont calculées à partir des résultats de sondages auprès des pêcheurs à la ligne et des dénombrements de l'effort au cours d'une période déterminée pour une pêche donnée et peuvent être utilisées pour déterminer l'état de stocks de poissons et les objectifs de gestion du poisson. Des sondages auprès des pêcheurs ont été effectués à la plage du ruisseau Lang du 17 août au 18 octobre 2008 et du 1er août au 30 septembre 2009, pour un total de 40 jours de sondage par année. Des dénombrements itinérants de l'effort ont été effectués toutes les heures chaque jour de sondage (d'une durée de sept heures). Dans le cadre de ces dénombrements, tous les pêcheurs à la ligne présents sur la plage et tous les bateaux de pêche récréative ont été pris en compte. Les données recueillies dans le cadre des sondages comprennent des données non exhaustives fournies par les pêcheurs à la ligne en train de pêcher au bord de l'eau (sondage itinérant) et des données exhaustives sur les sorties obtenues au retour des bateaux de pêche récréative (sondage aux points d'accès). Les données ont été utilisées pour déterminer l'effort quotidien moyen, l'effort total, les taux de prise et les prises totales par espèce et par type de jour pour les pêcheurs à la ligne du bord de l'eau et à bord de bateaux. Les données ont été comparées afin de relever les différences d'effort et de prises pour chaque type de pêche (du bord de l'eau ou à bord de bateaux) durant une même année ou d'une année à l'autre.

En 2008, l'effort a été plus important durant la première moitié de la période de sondage, et durant cette période, les pêcheurs à la ligne en bateau ont été les plus actifs et leur effort était plus grand que celui des pêcheurs du bord de l'eau. En 2009, la pêche a été pratiquée principalement du bord de l'eau et l'effort de pêche en bateau était faible. Les pêcheurs en bateau étaient plus actifs le matin et en soirée, tandis que l'effort des pêcheurs du bord de l'eau variait tout au long de la journée. En 2008, les taux de prise et les prises totales de saumons quinnat et coho ont diminué au fil du temps, les taux de prise et les prises totales de truite fardée anadrome en milieu côtier étaient variables et les taux de prise et les prises totales des pêcheurs en bateau étaient supérieurs à ceux des pêcheurs du bord de l'eau. Les taux de prise et les prises totales étaient généralement plus élevés et plus uniformes en 2009 qu'en 2008, et les pêcheurs à la ligne ont capturé deux espèces supplémentaires en 2009 (saumons rose et kéta). La résidence, le type d'engin et les méthodes utilisés par les pêcheurs interrogés ont été comparés et jugés semblables pour les deux années.

L'effort et les taux de prise des pêcheurs à la ligne ont probablement varié en fonction des conditions météorologiques, des marées, de l'abondance des poissons et des périodes de migration. Les taux de prise étaient généralement supérieurs en 2009, comparativement à 2008, comme en témoigne la plus grande remonte d'adultes dans le ruisseau Lang. La pêche est une pêche sélective du poisson marqué, et une limite de prises est en vigueur, ce qui pourrait avoir eu un effet négatif sur les prises des pêcheurs

du bord de l'eau rencontrés durant leurs périodes de pêche (biais liés à la « période de séjour »). Les recommandations relatives aux sondages itinérants auprès des pêcheurs sur la plage du ruisseau Lang comprennent une méthode exigeant l'utilisation de bateaux aux fins de dénombrement de l'effort et de sondage auprès des pêcheurs en bateau dans le cadre d'un véritable sondage itinérant ou l'étude de nouvelles méthodes d'échantillonnage, comme un sondage par courrier. Les données des sondages auprès des pêcheurs à la ligne devraient également comprendre le niveau d'expérience des pêcheurs interrogés afin de déterminer la différence sur le plan des taux de prise entre les pêcheurs novices et les pêcheurs expérimentés. Il pourrait être utile de tenir une séance d'information publique sur les résultats des sondages auprès des pêcheurs, les futures méthodes de collecte de données et l'importance de la gestion durable et du maintien de la pêche sur la plage du ruisseau Lang.

INTRODUCTION

Background

In recreational fisheries, creel surveys are important for gathering catch and effort information to fulfill objectives for conservation, research and management of fish stocks and to ensure the likelihood for future angling opportunities (Mallison and Cichra 2004, Mills 1992, Pollock *et al.* 1994). Creel studies may be designed for a specific fishery and target managed species or stocks (Mallison and Cichra 2004). The resulting creel estimates can provide information on expected catch and rates of catch, as well as information on total fishing activity in an area.

Many different creel survey methods are used to assess fisheries and it is important to implement the type of survey that is appropriate for a specific fishery and survey objective. Creel surveys can be used for recreational fisheries when gathering information to estimate catch rate, fishing effort and other parameters in the fishery. When the fishery can be accessed at multiple points by foot or boat, a roving creel survey is recommended where the angler is interviewed during their fishing trip and data are gathered for the partial trip (Pollock *et al.* 1994). In contrast, when the fishery can only be accessed from defined locations, an access-point survey is commonly used where the surveyor can remain at the access site on the shore and interview anglers at the end of their fishing trip (Pollock *et al.* 1994).

Creel surveys typically include effort measurements as well as angler catch data. Effort can be measured by instantaneous or progressive counts of fishermen at determined locations throughout the survey day and extrapolated to estimate the average daily effort and total effort over the survey period. Instantaneous counts throughout the survey day can be used to generate an average daily activity profile where the average number of anglers is shown for each hour during the day. Interviews are conducted where the observer gathers information on anglers' fishing trips and catch in order to determine catch per unit effort (CPUE) and estimate total catch. Analyses of catch and effort data can be used to compare day type (weekday and weekend) within the sampling period and track changes over time (monthly or weekly).

A beach fishery is one that is accessed by the beach at multiple locations where anglers have the opportunity to fish from the beach or near shore by boat. Recreational anglers have the potential of fishing in water of varying depth and substrate as well as targeting different species of fish depending on gear type and fishing method. Catch rates are calculated for the fishery but these rates can fluctuate depending on fish availability, angler fishing experience and gear/method used. The roving survey design assumes that the catch rate for anglers at the time of the interview is equal to the catch rate at the end of the fishing trip and the catch rate from interviewed anglers is representative of the catch rate for non-interviewed anglers (Pollock *et al.* 1994).

The purpose of this creel study is to estimate the recreational catch in the Lang Creek beach fishery for 2008 and 2009 using a roving creel survey design for beach-based anglers and an access creel survey design for boating anglers. Prior to this study, angler catch and effort at the Lang Creek beach fishery were unknown. Creel analyses are projected to estimate catch rates and total predicted catch and effort in the surveyed fishing periods and determine how catch rates and effort change, for each fishing type, over time and by day type. I used creel data from 2008 and 2009 to compare catch rates and effort between the two years. I also compared angler residency, gear type and access method between the two years.

Study Area

Lang Creek estuary is located north of Saltery Bay on Malaspina Strait and is about 10 km southeast of Powell River, BC (Figure 1). Lang Creek is an important recreational fishing location for the sport fishers of Powell River and surrounding area. In late summer and fall, anglers fishing at Lang Creek beach catch Chinook (*Oncorhynchus tshawytscha*), Coho (*O. kisutch*), Pink (*O. gorbuscha*) and Chum (*O. keta*) salmon, as well as Sea-run Coastal Cutthroat Trout (*O. clarki clarki*).

METHODS

Creel surveys were conducted from August 17 to October 18, 2008 and August 1 to September 30, 2009. Survey dates were selected using a stratified random sampling design. Each week was divided into weekday and weekend strata and each week included three to five survey days (one to three on randomly selected weekdays and two on weekends). Statutory holidays during the survey period were included in the weekend strata. Shifts focused on peak fishing times in August 2008, but were randomly selected for the remaining survey period of 2008 and all of 2009. Shifts were 6.5 hours long starting between 0700 and 1400 hours and ending between 1330 and 2030 hours. Forty survey days occurred in both 2008 and 2009; representing 63.5% and 65.6% of the study period in 2008 and 2009, respectively.

During the surveys, hourly effort counts of beach-based anglers fishing from Lang Beach and boat-based anglers launching from the beach and fishing the Lang Creek fish stocks were recorded. Angler interview data were also collected on each survey day which included interviews of beach-based anglers as they were intercepted during their fishing trip and interviews of boating anglers as they returned to the beach.

For this analysis, all interviews of beach-based anglers were treated as a roving survey where the angler was interviewed during their fishing trip (partial trips), and all interviews of boat-based anglers were treated as an access point survey where the angler was interviewed at the end of their fishing trip (complete trips) when they returned to the beach. All anglers fishing from floatation were treated as boat-based anglers. Catch

information from beach-based anglers that fished less than 0.5 hours were omitted from the analysis, however the demographic data from these interviews was used.

Although tides and weather often affect fishing effort and catch rates the survey schedule was randomized with respect to these factors and therefore they were not considered in the analysis. The survey was restricted to daylight hours as it was assumed that no angler fished outside of these hours (i.e. no full moon fishing occurred). All surveys, effort counts and angler interviews were conducted by the same observer for both years.

Effort Counts

Average daily effort and total fishing effort for both day-type and monthly strata were determined from the observer's daily effort summaries. For each hour (time block) during a shift, the observer was instructed to traverse the study area and count the total number of beach-based and boat-based anglers fishing at Lang Creek beach. Counts were made as quickly as possible from three or four vantage points from shore starting on the hour to minimize the likelihood of changes in the number of anglers during the counting period. The area was divided into four sub-areas to assist in counting accuracy.

The total count of beach-based and boating anglers was averaged for each hour and used to create a daily fishing activity profile stratified by day type (weekday and weekend), month, and fishing type. Activity profiles were averaged over weekday/weekend and monthly strata, using the same methods as the Strait of Georgia Creel survey (English *et al.* 2002).

An example effort data form is appended (Appendix A).

Angler Interviews

Angler interviews were conducted throughout the survey shift. Beach-based anglers were interviewed while they were fishing (partial trip interviews) and boating anglers were interviewed when they returned to the beach (complete trip interviews). Angler interview information consisted of four parts; summary, angler, catch and bio-sampling information.

Summary information included:

- daily number of interviews,
- date,
- observer,
- location,
- time block,
- water conditions and weather.

Angler information gathered included:

- angler residence,
- fishing start time,
- interview time,
- hours fished,
- hours intended to fish,
- target species,
- gear and fishing method used.

Catch information consisted of:

- species and number kept and/or released and
- adipose-clip status (clipped or unclipped).

Bio-sampling information was collected for fish kept by fishermen and included:

- species,
- length,
- sex,
- adipose-clip status,
- scale book and scale number (if Chinook sampled), and
- head with tag number for adipose-clipped fish.

Any comments about or from the fishermen were recorded on the interview sheet (Appendix B). The observer interviewed as many anglers as possible each shift while only interviewing individual anglers once per day.

Analysis

The analysis methods for both complete trip and partial trip sampling explained below are further detailed in Pollock *et al.* (1994).

Beach-based Anglers

Beach-based effort was determined by calculating the average number of anglers fishing (rods) that were counted during each time block for each stratum and day type. This results in an activity profile, which can visually represent the patterns of effort throughout the day for each stratum and day type. The average number of anglers (rods) for each time block was then summed to get the average daily effort or average number of rod hours per day for each month stratum and day type. The average daily effort (rod hours per day) was then used to calculate the total effort (rod hours) for each month stratum and day type by multiplying the calculated average daily effort by the total number of days in the stratum for each day type.

Roving surveys use a means of ratios estimator calculation for catch rate. The means of ratios calculation is a per angler estimator and calculates the mean anglers catch rate (Catch per Hour or CPUE). The catch rate is equal to the sum of the catch/hour fished

(sum of the CPUE for each interview) for each angler interviewed divided by the total number of interviews:

(1)

$$\hat{R}_1 = 1/m \sum_{i=1}^{m} \frac{c_i}{l_i}$$

where c_i is the catch for the i^{th} angler, l_i is the length of time fished (hours) up to the interview time for the i^{th} angler, and m is the number of interviews. Catch rates were calculated for each stratum, day type, species and adipose status for both kept and released landings. Harvest rate is the equivalent of catch rate for fish kept. Not all species (or adipose clip statuses) were caught by interviewed anglers in each stratum. When this is the case, it is impossible to calculate a catch rate and therefore catch rate is unknown.

CPUE multiplied by the total effort yield the total estimated number of fish caught by species and adipose status for kept and released fish for the monthly stratum, by day type.

Boat-based Anglers

Effort of boating anglers was calculated on a per boat-hour basis, regardless of the number of anglers in the boat. The average number of boats that were launched from the beach and fishing in the Lang Creek area was calculated by day type for each time block from the hourly effort counts. The sum of the average number of boats for all time blocks is the average number of boat hours per day or average daily effort. Total effort was then calculated by multiplying the average boat hours per day by the number of days in the stratum of the same day type.

Catch rates for access point surveys were derived using the ratio of means estimator, which is a per-day estimator and calculates the mean catch per boat hour. The catch rate is equal to the sum of all the angler interview catch by species, divided by the sum of the boat trip hours for all boating interviews:

$$\hat{R}_2 = \frac{\sum_{i=1}^{m} c_i}{\sum_{i=1}^{m} l_i}$$

(2)

symbols defined as above.

Catch rates were then multiplied by total effort for each stratum and day type to yield the total number of fish by species and adipose status for kept and released fish over the entire stratum period, by day type.

Within and Between Year Comparisons

For each year, the survey period was stratified into 2 time periods: August 17–September 17 and September 18–October 18 for 2008, and August 1-August 31 and September 1 – September 30 for 2009. Because the 2008 time periods were roughly 30 days, I termed them 'monthly' strata throughout this report, whereas the 2009 data fall in 2 standard months. The two years were analyzed separately for within year comparisons, by month and day type (weekday and weekend). For comparison purposes between years, data with a temporal overlap that was collected between August 17 and September 30 were used to compare 2008 and 2009 catch and effort information.

Biological Sampling and Supplementary Data

I calculated the average length for each species sampled by sex, as well as the age of sampled Chinook. Heads from adipose clipped Coho were examined for the presence of coded-wire tags. I evaluated the residential distribution of the anglers fishing in the area. I also examined the proportions of gear type and method used and catch landed using the various gear and methods.

RESULTS

2008

Effort

There were differences between beach-based and boating effort in 2008. For beach-based anglers weekday and weekend daily fishing activity was similar over the entire survey period with low activity from the morning to afternoon (Figure 2). The most variation in boat-based activity occurred in the mid-August to mid-September stratum with peak activity times in the mornings and evenings (Figure 3). There was a large decrease in boating activity in mid-September to mid-October relative to the first month (Figure 3). Boat-based anglers showed higher peaks in activity than beach-based anglers (peak beach-based was 5 anglers and peak boat-based was greater than 12; Figure 2 and 3).

Average daily effort was highest from mid-August to mid-September on weekdays for beach-based anglers and on weekends for boating anglers (Figure 4). In general, average daily fishing activity decreased throughout the survey period for both fishing modes, but the greatest differences over time were with the boating anglers (Figure 4). Overall, total beach-based effort was lower than total boat-based effort (Figure 5).

Catch Rate

During the survey period in 2008, a total of 301 anglers were interviewed during or after their fishing trips. Two interviews were omitted from the analysis because they were not targeting salmonid species. Catch rates were calculated using interviews from 242 land-based anglers and 57 boat-based anglers. Of all anglers interviewed, only 32 fish were caught and 12 of these were harvested.

On average, beach-based anglers fished 1.2 hours prior to being interviewed and intended to fish an average of 0.9 hours longer, resulting in an intended average fishing trip length of 2.1 hours. Boating anglers fished an average of 3.8 hours and few anglers intended to fish after being interviewed (seven intended to fish two to three hours longer).

Catch rates in 2008 ranged from 0.006 fish per rod hour to 0.073 fish per boat hour (Tables 1 and 2). The highest catch per unit effort (CPUE) was on weekends from mid-August to mid-September when 0.073 unclipped Chinook were landed and harvested per boat hour (Table 2). Similarly, from mid-August to mid-September, Cutthroat Trout were caught and released at a CPUE of 0.072 on weekdays from mid-August to mid-September. The lowest CPUE was 0.006 for unclipped Chinook on weekdays in the mid-August to mid-September strata by beach-based anglers (Table 1). During the mid-September to mid-October period, no fish were caught by boating anglers and beach-based anglers only caught and released Cutthroat Trout on weekends at a CPUE of 0.017.

The highest CPUE for Coho in the first month of the survey period was 0.027 for clipped fish on weekends by boating anglers and 0.023 for unclipped fish released by beach-based anglers on weekdays (Tables 1 and 2). Catch rates for Coho ranged as low as 0.008 clipped fish released per rod-hour on weekdays from mid-August to mid-September.

Estimated Catch

The estimated total catch for each species during 2008 was inconsistent from month to month and by fishing type, with Coho catches being the most comparable between beach-based and boating anglers (Tables 3, 4, 5 and 6). From mid-August to mid-September, beach-based anglers caught and released a total of 27 Coho (20 unclipped and 7 clipped fish) on weekdays and five adipose clipped Coho were kept on weekends. For boating anglers, 25 clipped Coho were kept and eight unclipped Coho were released on weekends. No Coho were caught during the mid-September to mid-October strata.

Chinook catch was much higher for boating anglers (Tables 4 and 6). Sixty eight unclipped Chinook were kept on weekends from mid-August to mid-September and 50 were released on weekdays and weekends combined (34 unclipped on weekdays and eight unclipped and eight unknown on weekends). This compares to only five unclipped Chinook caught and released by beach-based anglers on weekdays during the same

month strata. No interviewed anglers caught Chinook in the mid-September to mid-October strata.

Cutthroat Trout were caught much more readily by boating anglers, where 110 fish were caught and released from mid-August to mid-September (102 on weekdays and eight on weekends; Table 5). For beach-based anglers, only 16 fish were caught and released throughout the entire survey period, with 13 in the first month strata and three on weekends during in the second month strata (Table 3).

An estimated 316 fish (39% Chinook, 21% Coho and 40% Cutthroat Trout) were caught by all anglers fishing during the entire survey period from August 17 to October 18, with 263 caught by boat and 53 caught by anglers fishing from the beach (Figures 6 and 7). The total number of Chinook caught was 118 (68 kept and 55 released) and Coho catch was 65 (30 kept and 35 released). The total catch of Cutthroat Trout throughout the survey period was 126 fish, all of which were released. The observer, who has been fishing at this beach for 30 years, reported catch of as little as 1/5 to 1/6 of previous years (caught only two fish whereas his usual catch was 10-12 per season; Dan Hatch, personal communication).

Biological Sampling

There were twelve fish that were biologically sampled in 2008. All eight Chinook kept were unclipped (adipose present), and the four Coho were all adipose clipped. There were no coded-wire tags in either of the two heads that were collected from clipped Coho.

The three unclipped male Chinook averaged 717 mm and the five unclipped female Chinook averaged 10% larger than males at 796 mm. Of four adipose clipped Coho sampled, females averaged 505 mm (n=3) and the one male was 740 mm (46% larger than average female).

All Chinook that were sampled for age (n=7) were from the 2005 brood year and were therefore harvested at age three. Of these seven fish, five were females (average 796 mm) and two were males (average 830 mm).

Supplementary data

The home residency of the anglers fishing at the Lang Creek beach fishery during the 2008 survey period revealed that most anglers were residents of BC (91.6%, n=308, Figure 20). A small number were from elsewhere in Canada (2.6%), leaving only 5.7% of anglers from outside the country (Europe, Japan, USA and unknown locations). All interviewed anglers that caught fish were from BC except for one angler from Germany that caught a Coho and one angler from Alberta that caught a Cutthroat Trout. In 2008, anglers were not asked what region of BC they lived in.

In 2008, the preferred type of angler gear was a lure (85.7%) and all interviewed anglers that caught a Coho were using a lure (Figure 23). Anglers used a fly 11.4% of the time and bait was used only 2.3% of the time. Most of the Chinook caught were with bait (60%) and the remaining Chinook were caught with a lure (30%) or fly (10%).

From the interviews in 2008, boating anglers caught 47% of the catch (Chinook using bait 25% or a lure 9% and Coho using a lure 12.5%), whereas anglers with floatation caught 25% of the catch (all using a fly; seven Cutthroat and one Chinook). Anglers fishing with waders and from shore caught 22% (most success using a lure, but some with a fly) and 6% (when using a lure), respectively. Anglers using a lure caught 44% of the Chinook and anglers using bait caught 25%.

2009

Effort

In 2009, beach-based anglers were the more active than boating anglers throughout the average day (Figure 8 and 9). The greatest beach-based activity was during mid-day on weekends in September (Figure 8). During weekdays, beach-based anglers were most active in the evenings during both months (Figure 8). Activity was similar across both months and day types for boating anglers with slight peaks in the mornings and evenings (Figure 9).

Average daily effort was highest during weekdays in August and weekends in September for both beach-based and boating anglers (Figure 10). On average, daily boating activity was lower than beach activity throughout the entire survey period, especially in September with less than half the boat hours compared to beach-based rod hours (Figure 10).

Total effort peaked in September and over both months land based anglers spent twice as much time fishing as boating anglers (2655 rod hours vs. 1328 boat hours; Figure 11). Total boating effort was very similar across months with a slight increase in weekend effort in September compared to August (Figure 11).

Catch Rate

In 2009, a total of 498 anglers were interviewed in the two-month period from August 1 to September 30. Catch rate calculations included interviews from 437 beach-based anglers and 61 anglers fishing from boat or floatation. In total, 95 fish were caught and 51 were harvested by interviewed anglers.

Beach-based anglers fished on average 1.15 hours prior to being interviewed and intended to fish one additional hour after the interview (313 anglers intended to fish

between 0.5 to 6 hours longer). Boating anglers fished an average of 2.55 hours before being interviewed and 14 anglers intended to fish 0.5 to 2.5 hours after the interview.

The highest CPUE for land-based anglers was Pink salmon released in August (Table 7). During weekends in August, boating anglers landed Pink salmon at a much higher rate than beach-based anglers (Table 8). Catch rates for Pink salmon decreased considerably from August to September.

The maximum CPUE for harvested unclipped Chinook salmon were observed in August for boat-based anglers on weekdays and for beach-based anglers on weekends (Tables 7 and 8). No Chinook were caught by interviewed boating anglers on weekends in August or during the entire month of September.

Coho catch rates generally decreased for boating anglers over the survey period and were more variable for beach-based anglers (Tables 7 and 8). Boating anglers had the highest CPUE for Coho on weekdays in August (Table 8). Cutthroat Trout and Chum salmon were not readily or predictably caught in 2009 and were only caught by beach-based anglers. Cutthroat Trout were only caught in August and Chum salmon were only caught in September (Table 7).

Estimated Catch

In 2009, the total Chinook catch was similar from August to September for beach-based anglers with 16 caught (six released on weekdays and 10 kept on weekends) in August and 20 kept on weekdays in September (Tables 9 and 10). Boating anglers harvested 32 Chinook on weekdays in August and none in September (Tables 11 and 12).

Coho caught by beach-based anglers ranged from 19 kept (4 of which were unclipped) and 3 unclipped released in August to 36 adipose clipped kept and 11 unclipped released in September (Tables 9 and 10). Coho catch was much higher for boating anglers in August (89 vs. 22 caught in boat vs. beach-based angling), but September totals were similar (44 vs. 47; Tables 11 and 12).

Total Pink salmon catch was highest of all species in August with 110 (73 fish kept and 37 released) caught by boating anglers and 47 (20 kept and 27 released) by beach-based anglers (Tables 10 and 12).

Chum and Cutthroat were only caught by beach-based anglers (Table 9 and 10). Seven Chum salmon were caught and released in September and 14 Cutthroat Trout were released in August.

The total number of fish caught in 2009 from August 1 to September 30 was 531 (46% Coho, 13% Chinook, 38% Pink, 1% Chum and 3% Cutthroat Trout; Figures 12 and 13). Boat-based anglers caught 62.5% of the total catch.

Biological sampling

Thirty-two fish were biologically sampled in 2009. These fish were comprised of male and female unclipped Chinook (adipose present), unclipped and clipped Coho, and Pink salmon. One Chinook and one Coho were of unknown adipose status. There were no coded-wire tags in any of the eight heads that were collected from adipose clipped Coho.

Unclipped male Chinook averaged 780 mm (n=2) and one male of unknown adipose status was 700 mm. Unclipped female Chinook averaged 945 mm (n=2), which was 25% larger than males sampled. Two unclipped Coho were sampled and the male was 42% larger than the female (female was 520 mm and the male was 740 mm). Of the clipped Coho sampled, females averaged 621 mm (n=5) and males averaged 3% larger at 641 mm (n=13). One male Coho of unknown adipose status was 710 mm. Six Pink salmon were sampled and females averaged 473 mm (n=4) and the males were 485 mm (n=2).

Three unclipped Chinook were sampled for age. The age results indicated that the 900 mm unclipped female was from 2005 brood year (age four) and the 770 mm unclipped male was from the 2006 brood year (age three). The other sampled fish had regenerated scales but the scales showed three marine annuli for the 990 mm unclipped female, verifying that this fish was at least age four.

Supplementary data

In 2009, the home residency of interviewed anglers showed that 94.8% of the anglers were from BC, 2.5 % were from elsewhere in Canada (Figure 21) and the remaining 2.7% were from Germany, Italy, Turkey, USA and unknown locations (n=562, Figure 21). In 2009, the finer geographic scale of anglers (defined to city or town of residence) verified that most of the anglers fishing the Lang beach area were from Powell River and the surrounding area with 86.3% were from Powell River, the nearest town to the Lang Creek fishery (Figure 22). The majority of remaining anglers were from the lower mainland (Vancouver area; 6.4%), Vancouver Island (2.4%), the interior (2.3%), other areas on the Sunshine Coast (1.3%), the inside Islands (Texada; 0.4%) and unknown locations (0.9%). Of the 95 fish caught by interviewed anglers in 2009 (51 retained and 44 released), only five were caught by anglers from areas other than the Sunshine Coast (one from Vancouver, one from Nanaimo, one from Germany, one from Texas and one from an unknown location in BC).

In 2009, the preferred type of angler gear was a lure, catching 73% of the fish (Figure 24). Anglers using a fly caught 23% of the catch and anglers using bait caught 4%. When looking at fishing method, anglers using a boat caught 37% and anglers fishing from shore and using waders caught 30% each. The remaining 3% was from anglers using floatation. All anglers using bait and fishing from a boat were successful in catching Chinook or Coho but this was not a common combination (n=4). Boating anglers fishing with a lure caught 70% of the total catch from the interviews which were mostly Coho. This combination of boat and lure were successful in catching Chinook, Coho and Pink

salmon. Fly and bait by boat was also successful for Coho. Anglers using waders or fishing from the shore were also successful in catching Chinook, Coho and Pink salmon and most (47%) were caught using a lure. The only Chum caught was from the shore using a fly.

Between Year Comparisons

Effort

Beach-based anglers were more variable in their activity throughout the day than boating anglers (Figures 14 and 15). For the beach-based anglers, weekdays and weekends in 2008 as well as weekdays in 2009 followed similar activity patterns (Figure 14). Weekends in 2009 were the most active, showing a few peaks throughout the midday. Boating anglers showed a similar activity pattern for both years and day types with the majority of activity in the mornings and evenings (Figure 15). Boat-based anglers were most active on weekends in 2008.

Fishing effort patterns reversed between beach and boating activity from 2008 to 2009: beach-based effort increased and boat-based effort decreased across the two years (Figure 16 and 17). On average, weekends were more active than weekdays across years and fishing types. The exception was beach-based anglers in 2008 where weekday anglers fished more rod hours per day fishing than weekend anglers (Figure 16).

Catch Rates

Catch rates were calculated from 261 (199 beach-based anglers and 54 boating anglers) and 499 (393 beach-based anglers and 54 boating anglers) angler interviews in 2008 and 2009, respectively. Catch rates varied considerably across years and there was diversity in the species of fish caught (Tables 13 and 14). Only anglers interviewed in 2009 caught Pink or Chum salmon.

Beach-based Chinook CPUE was lower in 2008, whereas boat-based CPUE was higher in 2008 (Tables 13 and 14). In 2009, no Chinook were caught by interviewed boat-based anglers during the same survey time periods.

Unclipped Coho were caught and released more often in 2008 and clipped Coho were more readily caught in 2009 (Table 13). Coho catch was most successful by boating anglers in 2009, with more than 2.5 times higher CPUE (Table 14).

Beach-based anglers caught and released Cutthroat Trout in 2008 and 2009 (Table 13). In 2008 boating anglers had the highest CPUE for released Cutthroat Trout (Table 14). No Cutthroat Trout were caught by boating anglers interviewed in 2009.

Estimated Catch

There were considerable differences in catch numbers and species caught by beach-based and boating anglers (Tables 15, 16, 17 and 18). Pink catches were almost identical for beach-based and boating anglers in 2009 (Tables 16 and 18). Chum were caught and released only by beach-based anglers. There was no difference in Cutthroat trout catches by beach-based anglers in either year (12 fish per year), whereas boating anglers caught and released 109 in 2008 and none in 2009 (Tables 16 and 18).

Chinook and Coho catches were variable between years (Tables 15, 16, 17 and 18). Chinook catches were much higher for boating anglers in 2008 compared to beach-based anglers (Tables 16 and 18). In 2009, there were no Chinook caught by boating anglers that were interviewed but beach-based anglers landed almost five times more than the year before. There were higher Coho catches in 2009, especially by boating anglers and many more fish were kept than released (Table 16 and 18).

In total, during the same time period, 332 fish were caught in 2008 and 391 in 2009 (Figures 18 and 19). There was a switch in the proportion of kept catch between the two years (33% of total catch was kept in 2008 vs. 63% in 2009). Boating anglers in 2008 harvested over 20 times more and encountered more than three times the fish than beach-based anglers. In 2009 there were more fish released by beach-based anglers than boating anglers and of the fish kept, more were caught by boating anglers.

Supplementary data

Gear and methods used by anglers in 2008 and 2009 were similar for both years (Figures 23 and 24). The most common gear and fishing method for the Lang Creek beach fishery were anglers using a lure (>85% of total for both years) who were shore-based (51.3% of anglers in 2008 and 60.4% in 2009). Of anglers interviewed, fly fishermen comprised only 11.4% in 2008 and 14.0% in 2009 and bait was used only 2.3% of the time in 2008 and 0.4% in 2009. The use of waders was identical across years (27.7% of anglers). Few fishermen (<4% of anglers) used floatation as a method in both years.

It is important to note that the biggest difference between the fishing methods used was the decrease in boat use to less than half and subsequent increase of anglers fishing from shore (17.1% of anglers using boats in 2008 to only 8.1% in 2009; Figures 23 and 24). Another important difference was that shore-based fishing in 2009 was more successful than 2008 (increased from 6% to 30% of catch from interviews) and the use of floatation gear had very few landings in 2009 compared to 2008 (down from 25% to 4% of catch).

In 2008, it was apparent that anglers fishing from shore caught a lower proportion of the total catch (17% caught from shore and waders) compared to anglers on the water (83% caught by boat/floatation). In 2009, the total catch by beach-based anglers increased by 20% and boating anglers catch decreased by 20% (37% were caught by anglers using waders/shore-based method and 63% caught by anglers using boats or floatation).

DISCUSSION

Effort

Beach-based and boating activity profiles are likely adapted by angler and fish behaviour (Pollock *et al.*1994). Fishing activity during the 2008 survey period was low for beach-based anglers with small evening peaks that may reflect anglers fishing for short periods following their work day (Figure 2). Similarly to 2008, the evening peaks on weekdays and weekends in 2009 may perhaps be anglers fishing after work (Figures 8 and 9). In 2008 from mid-August to mid-September and during both months in 2009, boating anglers had higher activity in the mornings and evenings (Figures 3 and 9). Fish tend to feed in the early morning just after first light, hide from their predators during the day, and return to feed just before dark (Clark and Levy 1988). Boating anglers were most likely targeting fish actively feeding at dawn and dusk.

On average, in 2009, beach-based anglers were more active than boating anglers (Figures 8 and 9). Activity peaks for beach-based anglers occurred at various hours throughout the day, suggesting that there was no particular time of the day for either day type when anglers would usually fish (Figure 8). Also, most peaks were brief concluding that many anglers would only fish for a short period of time. It is common, especially for beach-based anglers, to fish opportunistically throughout the day and these anglers are more likely affected by tide cycles (Dan Hatch, personal communication). The Lang Creek beach fishery is very much a tidal fishery and at low tide at least 60% of the beach is unfishable and anglers must be very familiar with the area to know the few locations that are fishable at low tides (Dan Hatch, personal communication).

Daily effort is frequently higher on weekends compared to weekdays (Pollock *et al.* 1994). In 2008 this was true only for boating anglers during the mid-August to mid-September strata (Figure 4). In 2009, for both fishing methods, weekends were more active in September but in August weekdays had more effort (Figure 10). Many anglers at Lang beach were young anglers learning to fish (Dan Hatch, personal communication) and likely on summer holidays during August, consequently inflating weekday effort during this month. Daily activity profiles for the comparison between years showed that the most active strata for beach based anglers was weekends in 2009 and for boating anglers was weekends in 2008 (Figures 14 and 15).

Typically, recreational fishing effort changes month to month depending on the target fishery (Pollock *et al.* 1994). In 2008, there were large decreases in average daily effort and subsequently in total effort from the first month to the second (Figures 4 and 5). Anglers reported very low catch (Dan Hatch, personal communication) which could have negatively affected fishing effort during the second month of the survey. Much of the spawning salmon populations had already entered the river by the middle of September (middle of the 2008 survey) and this likely influenced angler effort in the bay and estuary. In 2009, average daily effort increased considerably from August to September

for beach-based anglers but boating effort was variable (Figure 10). This increase in beach activity could be attributed to the increased effort by beach-based fly-fishing anglers targeting Coho in 2009 (Dan Hatch, personal communication). Total effort did not show any difference from August to September for boating anglers whereas beach-based anglers showed more than 50% increase from August to September (Figure 11).

Weather and fishing conditions can have a large impact on effort. There was very little boating activity in the mid-September to mid-October strata in 2008 (Figure 3). This suggests that the weather was too poor for boating or anglers were just not catching any fish (due to the spawning salmon moving into the river) and therefore did not fish any longer for the season. Fishing conditions recorded during the effort counts verified that when conditions were poor, especially mid-September to mid-October, there were often few or no anglers observed. In 2009, when overall weather conditions were recorded as the roughest, anglers would still be fishing from the beach but few to no boats would be observed fishing. The weather in 2009 was very hot and sunny and on the water the winds could have been more of a deterrence for boating anglers compared to beach fishers.

There was an evident switch in average daily effort and total effort between beach-based and boating activity when comparing the same time periods of 2008 to 2009 (Figures 16 and 17). Boat-based anglers were more active in 2008 and beach-based anglers were more active in 2009. The switch in boating vs. beach-based activity could have been due to variations in weather conditions or the increased success of beach-based anglers in 2009. Boating was a more favourable method in 2008 and it is possible that water conditions were smoother that year. Beach-based anglers were more active in 2009 and were less affected by weather in that they continued to fish despite deteriorating conditions compared to 2008. There is an increasing interest and awareness of successful recreational beach fishing at Lang Creek in recent years and more young anglers are learning to fish (Dan Hatch, personal communication) which could consequently be increasing angler effort.

Catch Rates and Total Catch

Catch rates often reflect fish abundance and can be considered as an index of abundance for migrating populations (Bernard *et al.*1998a). In 2008, catch rates were low for all species throughout the survey period and dropped greatly in the second month (Tables 1 and 2). Due to the migration into natal streams prior to spawning, landed Chinook and Coho decreased to zero by the middle of the survey period and most catches during the first month were in the morning hours. The total escapement for Lang Creek 2008 and 2009 returns were enumerated using a fixed site census for an absolute abundance estimate. The lower catches in 2008 reflect the trend in that the 2008 returns were lower than the averages for all species (Figure 25). Chinook returns have been relatively consistent, but catches varied in that beach based anglers were more successful in 2009 when boating anglers were not successful at all (Figures 18 and 19). Coho and Pink returns were very low in 2008 and very high in 2009 compared to the previous 5-year

averages and this was reflected in the CPUE and total catch of these species (Figure 25). Chum escapement was much lower than the average and catches were very low to zero for both years.

In 2008, total Chinook and Cutthroat Trout catches were very low for beach-based anglers compared to boating anglers indicating that boating anglers were much more successful in catching these fish (Tables 3, 4, 5, and 6). In 2009, Cutthroat Trout were only caught and released by beach-based anglers in August and there were no Cutthroat caught in September suggesting that these fish had migrated into the river. Catch rates from 2008 to 2009 showed that Chinook were caught at a higher rate for beach-based anglers in 2009 and these anglers were more likely to harvest the fish (Table 13). Boating anglers had reasonably high catch rates for Chinook in 2008 but were not successful catching Chinook in 2009 (Table 14). Three Chinook releases were recorded from anglers fishing from the shore and it is possible that these fish were released due to their size (less than 62cm).

Angler catch in 2009 included two species that were not seen in the 2008 interviews; Pink and Chum salmon. Catch rates in 2009 revealed that Pink salmon were caught more often than other species, especially in August and were more readily caught by boat (Table 7 and 8). There were high returns of Pink salmon to many rivers on the inside waters of Vancouver Island and the Sunshine Coast compared to previous years likely due to the two-year cycle of Pink salmon (low returns in even years and high returns in odd years). The presence of Pink salmon in 2009 was highly noticeable around the coast with high marine catches and many rivers saw Pink returns of a scale much higher than normal. The total Pink return for Lang Creek in 2009 was 4775 which is the highest return on record for Lang Creek (Figure 25). Chum returns to Lang Creek were low for both 2008 and 2009 compared to the previous 5-year average, contributing to low Chum encounters by anglers (Figure 25). Chum salmon were only caught by beach-based anglers in September 2009 (Tables 10 and 15) which coincides with the later run timing of Chum compared to other species.

Coho catch numbers were comparable between beach-based and boating anglers in 2008 and it is interesting to note that most Coho caught from the beach were released and most caught from a boat were retained (Figures 6 and 7). In 2009, Coho catch was higher in August for boating anglers but lower for beach-based anglers (Tables 10 and 12). Coho catch in general, especially clipped fish, were higher in 2009 particularly for boating anglers (Table 18). Increased Coho encounters are likely due to the escapement numbers of Coho into Lang Creek in 2009 being much higher than 2008 and the previous 5-year average (Figure 25). Fishing regulations dictate that Coho must be adipose clipped fish to be harvested. In 2009, of the 16 unclipped Coho caught by interviewed anglers, five were retained, which is in contravention of recreational fishing regulations. One of these anglers was a First Nations fisherman who retained two unclipped Coho. One other Coho was misidentified as a Pink, one was injured by a seal while the angler was reeling it into the boat (seal ate half of the tail) and the remaining fish was simply illegally harvested.

Supplementary data

It is clear that most of the anglers that fish in the Lang Creek area are local BC residents (Figure 20). The anglers from Powell River are most familiar with this fishing location compared to visitors to the area and locals are likely very familiar with the fishery and its habitat components at varying tide levels. The majority of people visiting this area as tourists likely hire a guide and focus effort at other locations. Further analysis of how catch rates differed from local to non-local residency as well as experienced and inexperienced anglers would be useful and informative especially for beach-based anglers where the fishery is dependant on knowledge of the area and tidal fluctuations.

The catch rate estimator assumes that fish catchability remains constant and all factors such as fish and fisher behaviour are random (Pollock *et al.* 1997, Shuter *et al.* 1998). This assumption may not be true when admitting non-random movement habits of fish with respect to habitat preference and predator avoidance (Clark and Levy 1988, Keefe *et al.* 2009). Low tides and seal presence may have influenced the distribution of fish and therefore negatively affected catch rates, especially for beach-based anglers. Experienced local anglers may have had an advantage based on their knowledge of the fishery and their ability to locate and capably exploit aggregates of fish populations (Shuter *et al.* 1998) based on fishing location, tides and weather conditions. In the future, anglers could also be asked about their experience level so it is possible to determine the difference in catch rates for novice anglers and expert anglers. It would also be interesting to determine if there are guides consistently utilizing the fishery. The observer did note on one of the interviews during 2009 that it was a guided trip, but the anglers did not catch any fish.

During the 2009 season, the observer had the opportunity to interview almost twice as many anglers than in 2008 during the same time period (261 anglers in 2008 and 499 anglers in 2009). Of these interviews, the same number of boating anglers were interviewed each year (54 interviews), but there was large difference in the number of beach-based anglers that were interviewed (199 in 2008 and 393 in 2009). The interviews in 2009 showed a higher CPUE for all species (except Cutthroat Trout) and many more fish were observed by the surveyor. This shows that there were more anglers fishing from the beach in 2009 during the randomized survey days and the interviews may have captured a better representation of the anglers' catch during this year.

Overall Discussion, Future Recommendations and Conclusion

For this survey, data collected from beach-based anglers were designated as a roving survey type. Roving surveys have a potential of introducing biases into estimates. A common bias in roving surveys is "length-of-stay" bias where the probability of an angler being interviewed is proportional to the length of their complete fishing trip (Pollock *et al.* 1994). This infers that anglers that only fish for a short time have little chance of

being interviewed and anglers that fish longer have a much higher chance of being interviewed. Bernard *et al.* (1998a and 1998b) showed that "length-of-stay" bias can be avoided if the sampling periods are the same length as a fishing day or if hourly effort counts are instantaneous and do not interfere with interviews. In the current study, anglers that fished short periods of time (especially less than one hour) were most likely missed by the observer in the interviews and effort counts. The interview "shadow" that is produced when angler interviews are conducted during counts could have negatively biased the catch estimates (Bernard *et al.* 1998a, Pollock *et al.* 1994).

It would be beneficial to the effort counts if the observer was in a boat roving from one end of the beach to the other while counting each hour instead of trying to reach each vantage point from the beach to get a full count. Pollock *et al.* (1994) noted that if the count of anglers each hour is done in less than 15 minutes, it is safely considered instantaneous and counts that take significant time are considered progressive and must be treated differently. In this survey, the observer was required to reach three or four vantage points within the hour to obtain an instantaneous count of anglers in the whole area which took more than 15 minutes when there were numerous anglers to interview on the way. A boat-based count would result in a more accurate instantaneous count since the count could be done in a more timely fashion.

When there is a bag limit on a fishery, a negative bias is introduced which decreases the catch rate estimate for incomplete trips (roving interviews of beach-based anglers). With a bag limit in place, anglers will most likely leave the fishery as soon as their limit is caught which decreases the probability of interviewing anglers that have landed their daily catch limit. In turn, this decreases the average catch rate calculated. Pollock *et al.* (1997) suggest that when a bag limit is in place, roving surveys are not appropriate and that biases in catch rate are inversely related to bag limit size. In other words, as the bag limit goes up, the potential bias decreases. In the Lang Creek area a bag limit of two Chinook (length of 62 cm or greater) and two adipose clipped Coho was in place. During the surveys, the only anglers that had reached their bag limit for Chinook or Coho when interviewed were complete trip interviews of boating anglers; no beach-based anglers had reached their bag limit when intercepted for an interview. The bag limit restrictions in the survey area probably negatively affected the catch rate estimate for the beach-based anglers in both years. Furthermore, the catch rate estimator for incomplete fishing trips provides only an estimate of the catch rate for the completed trip. Without taking into account the bag limit effect, short trips that may have been missed and experienced anglers that know the fishery well, the catch rate will always contain bias.

This survey provided interview information of beach-based and boat-based anglers where two different calculations were utilized for treatment of these differing types of survey data (roving vs. access respectively). It has been observed that the two different calculations for incomplete and complete trips can yield different results even when comparing the same set of anglers' incomplete and complete trip data. Keefe et al. (2009) observed that when estimating catch rate from the same anglers' incomplete trip and complete trip information, the catch rate estimators showed a positive bias in the incomplete trip catch rate estimation. When the same set of anglers' complete trip data

were used to calculate both estimators (ratio-of-means estimator and means-of-ratios estimator) there was a 19% difference in the results. When exploring the two different estimators using data in this survey, the estimate was not consistently low or high.

The combination of beach-based and boating anglers being interviewed by one observer posed a problem because the observer was solely based on land. All interviews from boaters were conducted when intercepted on shore (usually at the end of their trip), whereas interviews of beach-based anglers were conducted during the anglers trip. Pollock *et al.* (1994) state that roving surveys of boating anglers should be conducted by boat as well so that the anglers are intercepted during the fishing trip and not at the end. Using this method, all boating anglers would have an equal chance of being interviewed, not just boaters that are opportunistically intercepted at some point when they return to the beach.

Future creel surveys for this area should be more selective of the inclusion of boats for the analysis of effort. The boaters counted should only include the boats that are launching and returning at Lang beach. This may be difficult due to the observer being uncertain where boats were launched from when doing counts (particularly at the beginning and end of a shift). Other boaters that are fishing the Lang stock that enter the area from other access points can be counted separately to determine increased fishing pressure of these boaters from outside the area. Also, for the purpose of a true roving survey, interviews of boating anglers should be conducted from a boat where the angler can be intercepted during the fishing trip and asked where the boat was launched from (Pollock *et al.* 1994).

Seal predation was a problem that became apparent in 2008 compared to the past. Anglers reported that seals were moving right into the estuary, taking fish off anglers' lines and sometimes waiting only 10 to15 meters from the beach (Dan Hatch, personal communication). Seal populations have been increasing in the past few decades in many areas and many salmon stocks have decreased. Seals have become an increasing pressure on migrating salmon in estuaries and bays where salmonid species are targeted as they attempt to enter the rivers to spawn or as juvenile salmon outmigrate to the ocean. A study in the Alsea River basin in Washington revealed that an estimated 21% of the previously depleted pre-spawning population of the Coho salmon run was consumed by harbour seals (*Phoca vitulina*) during fall 2002 (Wright *et al.* 2007). This was the first time in 30 years that seals have been a problem at the Lang Creek beach fishery (Dan Hatch, personal communication) and the presence of seals may have caused the salmon to retreat to deeper water to conceal themselves from the seals, especially when the tide was low. It is likely that when salmon remain in the estuary longer waiting for water levels to rise for upstream migration, the impact of seal predation will increase (Nagtegaal *et al.* 2004).

Anglers on the beach may have been largely affected by bad weather when fish may have retreated to deeper water. Although weather conditions and tides were not incorporated into this analysis, these factors may have had a great deal of influence on angler and fish behaviour, especially for the anglers fishing from the tidal dependant beach. Tidal cycles

commonly have a large impact on fish catchability, particularly on beach fisheries such as Lang Creek. The tidal fishery of Lang creek has a very limited beach fishery at low tide and anglers fishing from shore at low tide needed to have waders and a good arm to be able to fish in water with enough depth (Dan Hatch, personal communication). This probably negatively affected catch rates for beach-based anglers at these times due to the effects on fish and angler behaviour (Shuter *et al.* 1998). Low tides would not have affected boating anglers in this way and therefore on average, boaters potentially had higher catch rates than beach-based anglers and were not as restricted as to the times they could successfully catch fish. The influence of tides on catchability was not factored into my analysis of this study since the survey design was random with respect to tidal cycles.

Although these were the first two years a creel survey was conducted on the Lang Creek fishery, it was reported that catch was very low compared to previous years, especially in 2008 (Dan Hatch, personal communication). Many factors likely influenced fish catchability at Lang Creek during this study. This reduced catch reported could be due to fish abundance and predation pressures. Catch rates and estimates may have been negatively influenced due to length of stay and bag limit effects. Also, anglers that fished for less than one hour could have been missed in the hourly effort counts resulting in an underestimate of effort and subsequently total catch. The low catch rates could be attributed to the high number of beach-based anglers that failed to catch a fish prior to the interview but could have caught something following the interview as they continued to fish.

Jones *et al.* (1995) suggest that in order to achieve satisfactory confidence in the catch rate estimation with an acceptable level of error, 100 anglers should be interviewed. Interviewed beach based anglers exceeded this suggested sample size in both years, whereas boat-based angler interviews included on 54 interviews per year. Mallison and Cichra (2004) suggest that when modest accuracy (~5% error) is acceptable for managing and gathering information on the fishery to meet specific study objectives, mail-in questionnaires may be a potential alternative to costly on-site interviews. Conversely, substantial biases may be introduced with the mail-in survey method, such as anglers failing to report trips where there was no catch (thus positively biasing the catch rate estimator) or angler recall bias. These issues must be addressed carefully and continuously (Pollock *et al.* 1994). It has been found that, without compromising precision, the accuracy of total catch estimates may be improved by the use of correction factors or regression analysis to provide a corrective model (Keefe *et al.* 2009, Mallison and Cichra 2004). Due to time and budget constraints and the difficulty in surveying a substantial proportion of each type of angling activity at the Lang Creek beach fishery, it may be worthwhile to explore the possibility of alternate sampling methods as outlined in Pollock *et al.* (1994).

Since most anglers fishing the Lang Creek beach fishery are locals to the area, it may be useful to host a session for these anglers to be informed about the results of the 2008 and 2009 surveys and introduce the mail-in surveys cards for their future angling trips. Anglers could be informed about the importance of data submission even when there was

no catch and how the information gathered aids in properly managing fish stocks in their area to conserve future angling opportunities and sustainable fish populations.

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Table 1: 2008 Catch rates for beach-based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclippped	Coho clipped	Chinook unclipped
Aug-Sept	WD Kept	-	-	-	-
	WD Released	0.009	0.023	0.008	0.006
	WE Kept	-	-	0.016	-
	WE Released	0.016	-	-	-
Sept-Oct	WD Kept	-	-	-	-
	WD Released	-	-	-	-
	WE Kept	-	-	-	-
	WE Released	0.017	-	-	-

Table 2: 2008 Catch rates for boat-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Chinook clipped
Aug-Sept	WD Kept	-	-	-	-	-
	WD Released	0.072	-	-	0.024	-
	WE Kept	-	-	0.027	0.073	-
	WE Released	0.009	0.009	-	0.009	0.009
Sept-Oct	WD Kept	-	-	-	-	-
	WD Released	-	-	-	-	-
	WE Kept	-	-	-	-	-
	WE Released	-	-	-	-	-

Table 3: 2008 Estimated total catch for beach-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped
Aug-Sept	WD Kept	-	-	-	-
	WD Released	8	20	7	5
	WE Kept	-	-	5	-
	WE Released	5	-	-	-
Sept-Oct	WD Kept	-	-	-	-
	WD Released	-	-	-	-
	WE Kept	-	-	-	-
	WE Released	3	-	-	-

Table 4: 2008 Total estimated catch for beach-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped
Total Aug-Sept	Kept	-	-	5	-
	Released	13	20	7	5
Total Sept-Oct	Kept	-	-	-	-
	Released	3	-	-	-

Table 5: 2008 Estimated total catch for boat-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Chinook unknown
Aug-Sept	WD Kept	-	-	-	-	-
	WD Released	102	-	-	34	-
	WE Kept	-	-	25	68	-
	WE Released	8	8	-	8	8
Sept-Oct	WD Kept	-	-	-	-	-
	WD Released	-	-	-	-	-
	WE Kept	-	-	-	-	-
	WE Released	-	-	-	-	-

Table 6: 2008 Total estimated catch for boat-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Chinook unknown
Total Aug-Sept	Kept	-	-	25	68	-
	Released	110	8	-	42	8
Total Sept-Oct	Kept	-	-	-	-	-
	Released	-	-	-	-	-

Table 7: 2009 Catch rates for land based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
August	WD Kept	-	0.009	0.011	-	0.026	-
	WD Released	0.019	0.007	-	0.013	0.034	-
	WE Kept	-	-	0.032	0.032	0.026	-
	WE Released	0.016	-	-	-	0.035	-
September	WD Kept	-	-	0.018	0.019	0.014	-
	WD Released	-	0.010	-	-	0.010	0.007
	WE Kept	-	-	0.027	-	-	-
	WE Released	-	0.002	-	-	0.003	-

Table 8: 2009 Catch rates for beach-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Pink
August	WD Kept	-	0.139	-	0.069	-
	WD Released	-	-	-	-	-
	WE Kept	0.117	0.117	-	-	0.351
	WE Released	-	-	-	-	0.176
September	WD Kept	-	0.051	-	-	-
	WD Released	0.017	-	-	-	0.034
	WE Kept	0.015	0.046	0.046	-	0.015
	WE Released	0.015	-	-	-	-

Table 9: 2009 Estimated total catch for beach-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
August	WD Kept	-	4	5	-	12	-
	WD Released	9	3	-	6	16	-
	WE Kept	-	-	10	10	8	-
	WE Released	5	-	-	-	11	-
September	WD Kept	-	-	18	20	14	-
	WD Released	-	10	-	-	11	7
	WE Kept	-	-	18	-	-	-
	WE Released	-	1	-	-	2	-

Table 10: 2009 Total estimated catch for beach-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
Total August	Kept	-	4	15	10	20	-
	Released	14	3	-	6	27	-
Total September	Kept	-	-	36	20	14	-
	Released	-	11	-	-	13	7

Table 11: 2009 Estimated total catch for boat-based anglers by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Pink
August	WD Kept	-	65	-	32	-
	WD Released	-	-	-	-	-
	WE Kept	24	24	-	-	73
	WE Released	-	-	-	-	37
September	WD Kept	-	20	-	-	-
	WD Released	7	-	-	-	13
	WE Kept	4	12	12	-	4
	WE Released	4	-	-	-	-

Table 12: 2009 Total estimated catch for boat-based anglers by month for each species kept and released (and by adipose status for Chinook and Coho)

		Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Pink
Total August	Kept	24	89	-	32	73
	Released	-	-	-	-	37
Total September	Kept	4	32	12	-	4
	Released	11	-	-	-	13

Table 13: 2008 and 2009 Comparison of catch rates for beach-based anglers (fish/rod hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
2008	WD Kept	-	-	-	-	-	-
	WD Released	0.010	0.024	0.008	0.006	-	-
	WE Kept	-	-	0.012	-	-	-
	WE Released	0.005	-	-	-	-	-
2009	WD Kept	-	-	0.012	0.013	0.019	-
	WD Released	0.008	0.011	-	0.006	0.023	0.006
	WE Kept	-	-	0.033	-	0.005	-
	WE Released	-	0.001	-	-	0.007	-

Table 14: 2008 and 2009 Comparison of catch rates for boat-based anglers (fish/boat hour) by stratum and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Chinook unknown	Pink
2008	WD Kept	-	-	-	-	-	-	-
	WD Released	0.070	-	-	-	0.023	-	-
	WE Kept	-	-	0.027	-	0.071	-	-
	WE Released	0.009	0.009	-	-	0.009	0.009	-
2009	WD Kept	-	-	0.071	-	-	-	-
	WD Released	-	0.014	-	-	-	-	0.029
	WE Kept	-	0.013	0.067	0.040	-	-	0.067
	WE Released	-	0.013	-	-	-	-	0.040

Table 15: 2008 and 2009 Comparison of estimated total catch for beach-based anglers by year and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
2008	WD Kept	-	-	-	-	-	-
	WD Released	10	25	8	6	-	-
	WE Kept	-	-	5	-	-	-
	WE Released	2	-	-	-	-	-
2009	WD Kept	-	-	18	20	28	-
	WD Released	12	16	-	8	34	8
	WE Kept	-	-	30	-	5	-
	WE Released	-	1	-	-	6	-

Table 16: 2008 and 2009 Comparison of total estimated catch for beach-based anglers by year for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Chinook unclipped	Pink	Chum
Total 2008	Kept	-	-	5	-	-	-
	Released	12	25	8	6	-	-
Total 2009	Kept	-	-	48	20	33	-
	Released	12	17	-	8	40	8

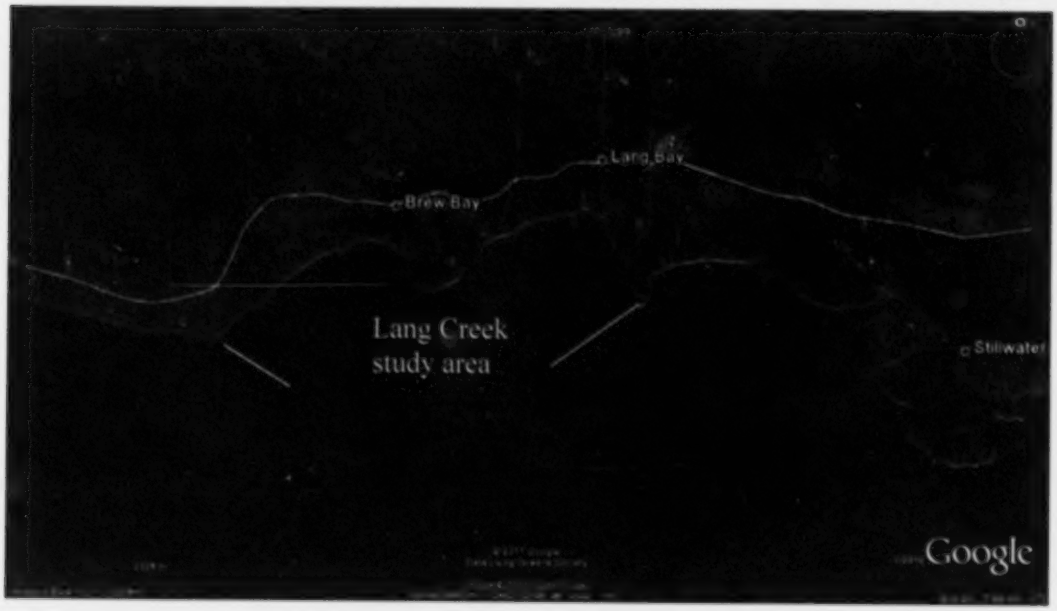
Table 17: 2008 and 2009 Comparison of estimated total catch for boat-based anglers by year and day type (WD = Weekday, WE = Weekend) for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Chinook unknown	Pink
2008	WD Kept	-	-	-	-	-	-	-
	WD Released	100	-	-	-	33	-	-
	WE Kept	-	-	28	-	76	-	-
	WE Released	9	9	-	-	9	9	-
2009	WD Kept	-	-	55	-	-	-	-
	WD Released	-	11	-	-	-	-	22
	WE Kept	-	7	33	20	-	-	33
	WE Released	-	7	-	-	-	-	20

Table 18: 2008 and 2009 Comparison of total estimated catch for boat-based anglers by year for each species kept and released (and by adipose status for Chinook and Coho)

		Cutthroat	Coho unclipped	Coho clipped	Coho unknown	Chinook unclipped	Chinook unknown	Pink
Total 2008	Kept	-	-	28	-	76	-	-
	Released	109	9	-	-	43	9	-
Total 2009	Kept	-	7	87	20	-	-	33
	Released	-	17	-	-	-	-	41

Figure 1: Map of study area (obtained from Google Earth™ on January 7, 2009)



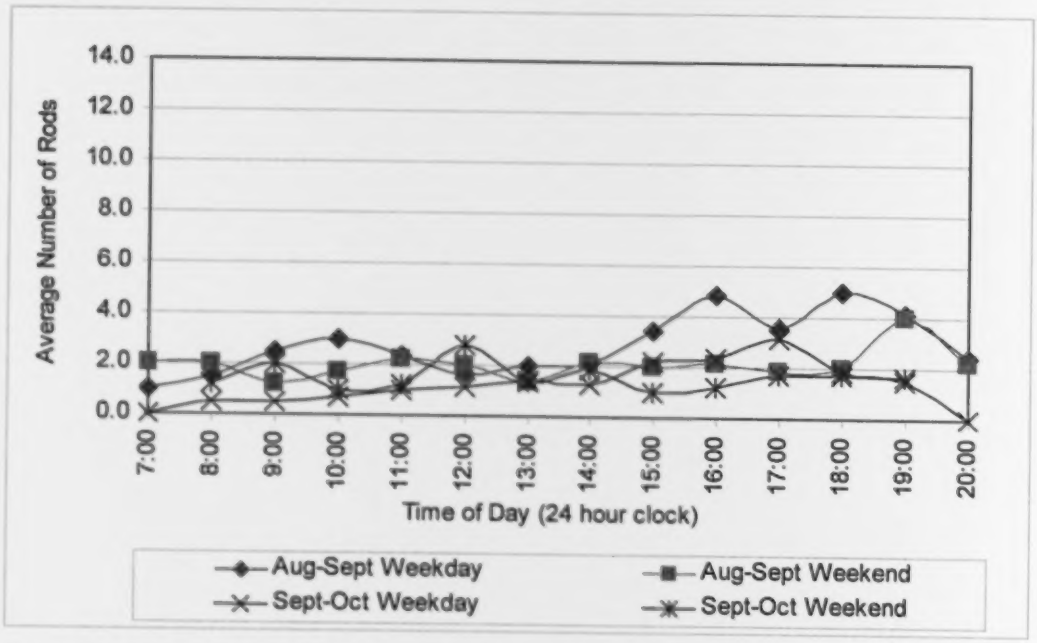


Figure 2: Average daily effort profile for beach-based anglers by stratum in 2008

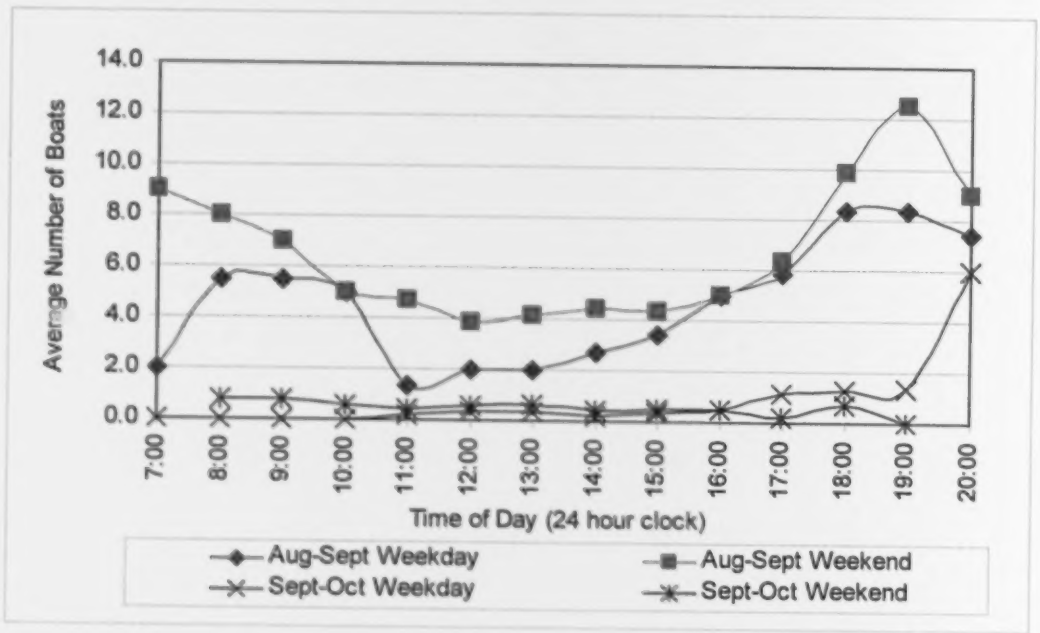


Figure 3: Average daily effort profile for boat-based anglers by stratum in 2008

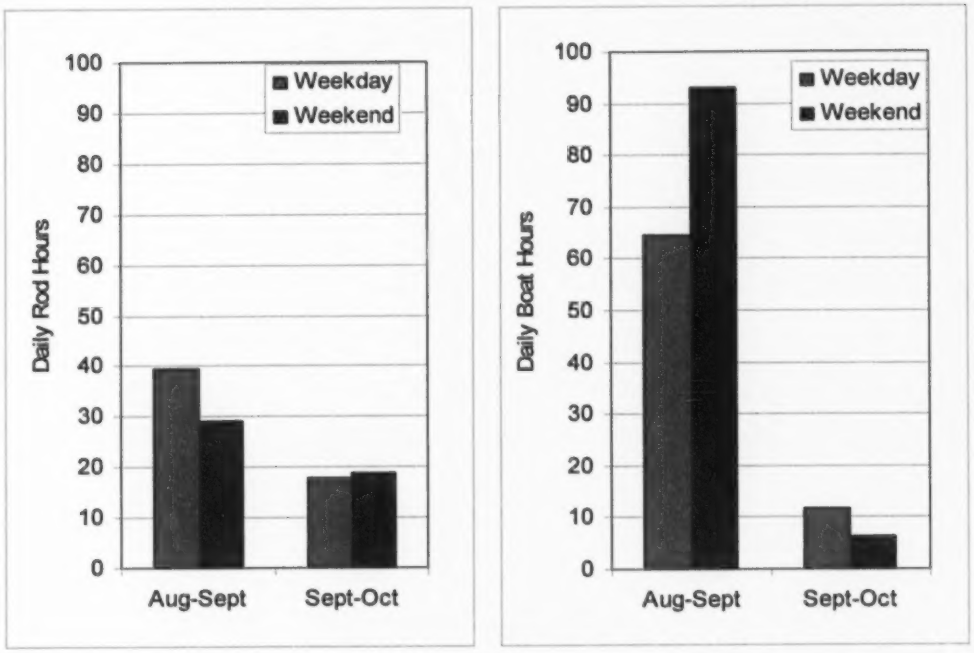


Figure 4: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008

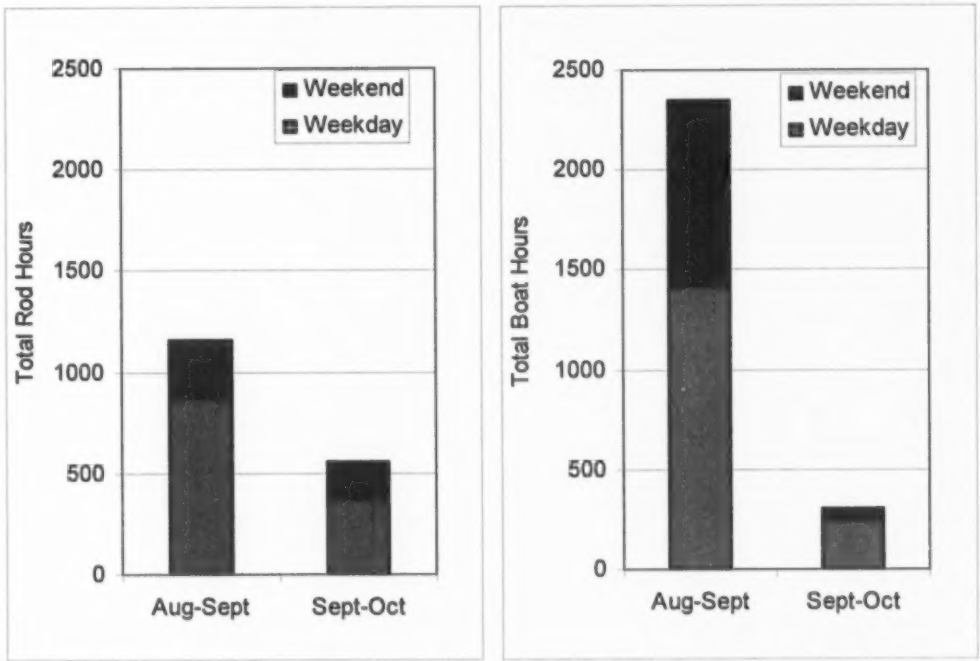


Figure 5: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type in 2008

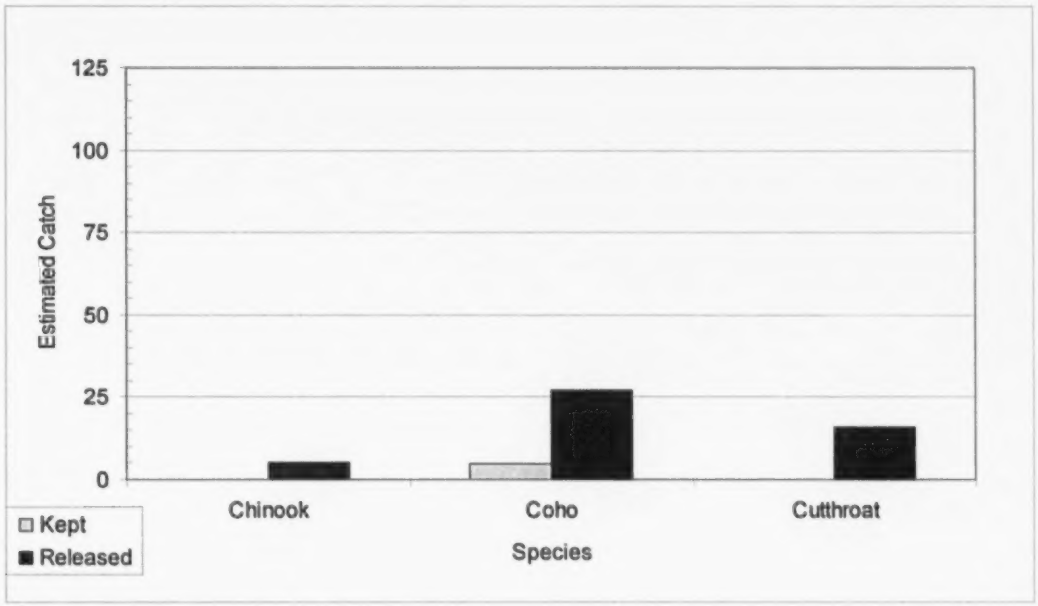


Figure 6: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout for the 2008 survey period

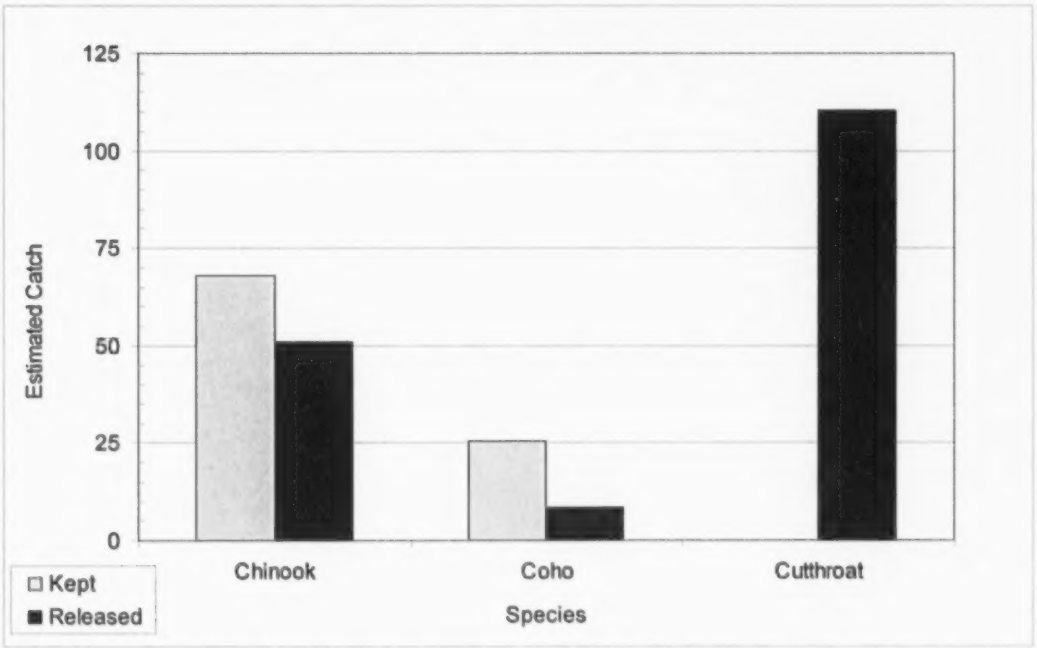


Figure 7: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout for the 2008 survey period

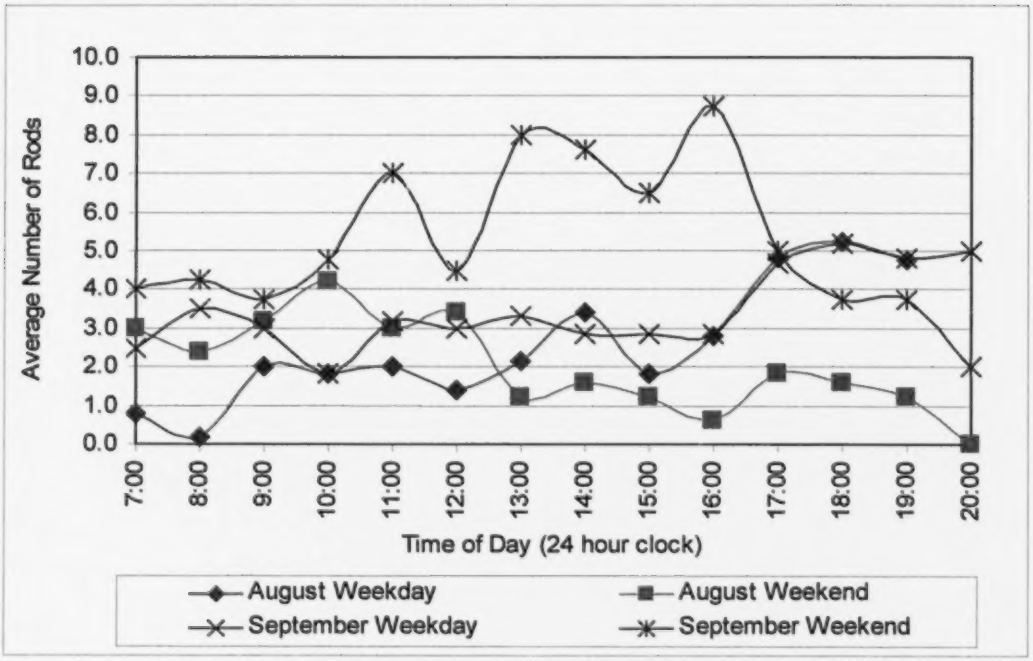


Figure 8: Average daily effort profile for beach-based anglers by stratum in 2009

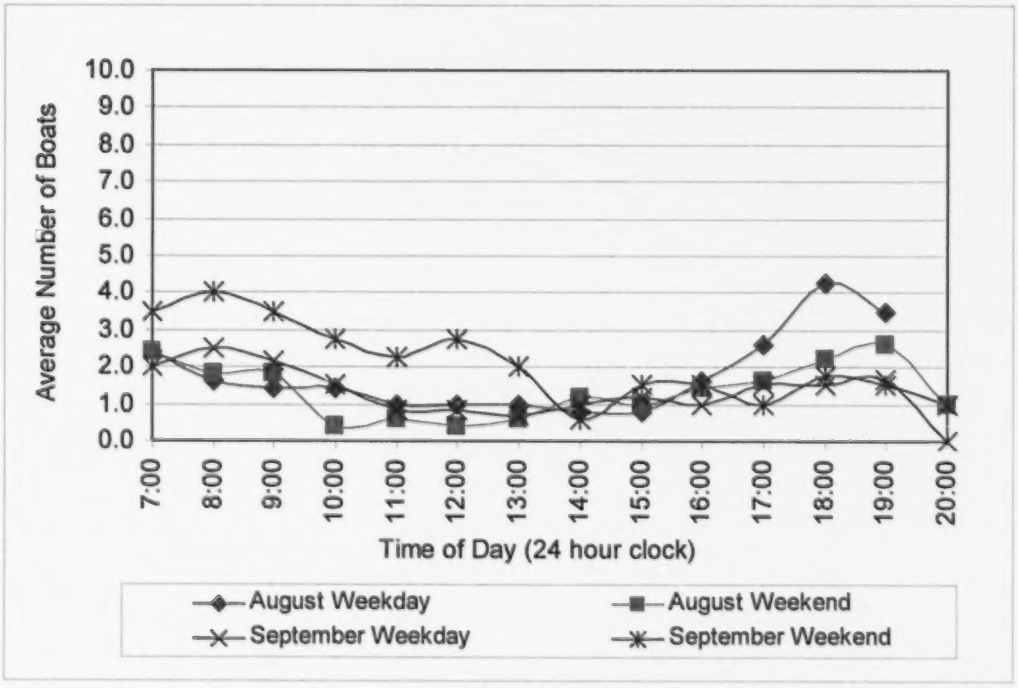


Figure 9: Average daily effort profile for boat-based anglers by stratum in 2009

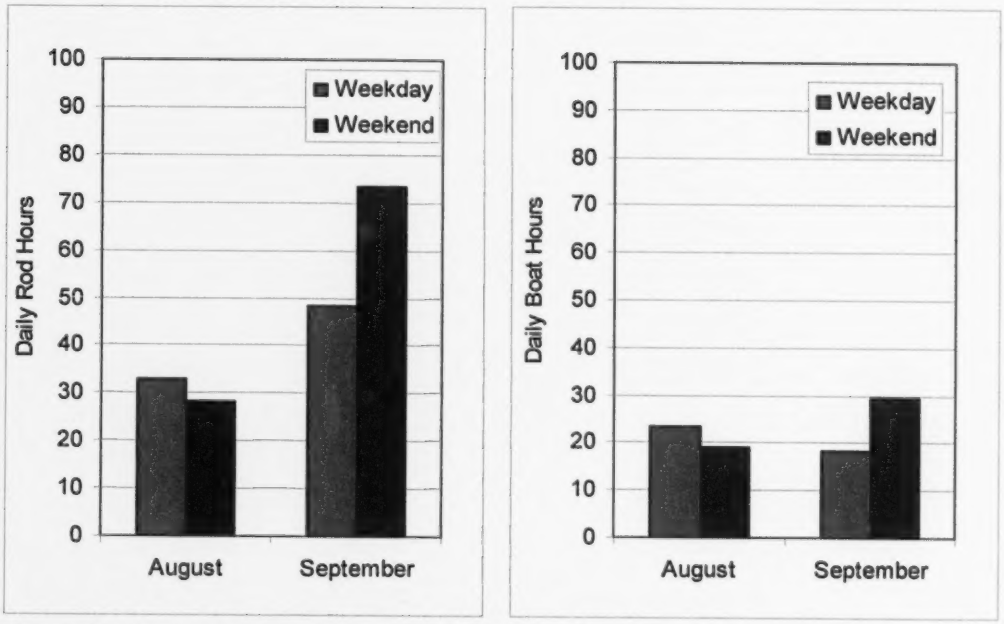


Figure 10: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2009

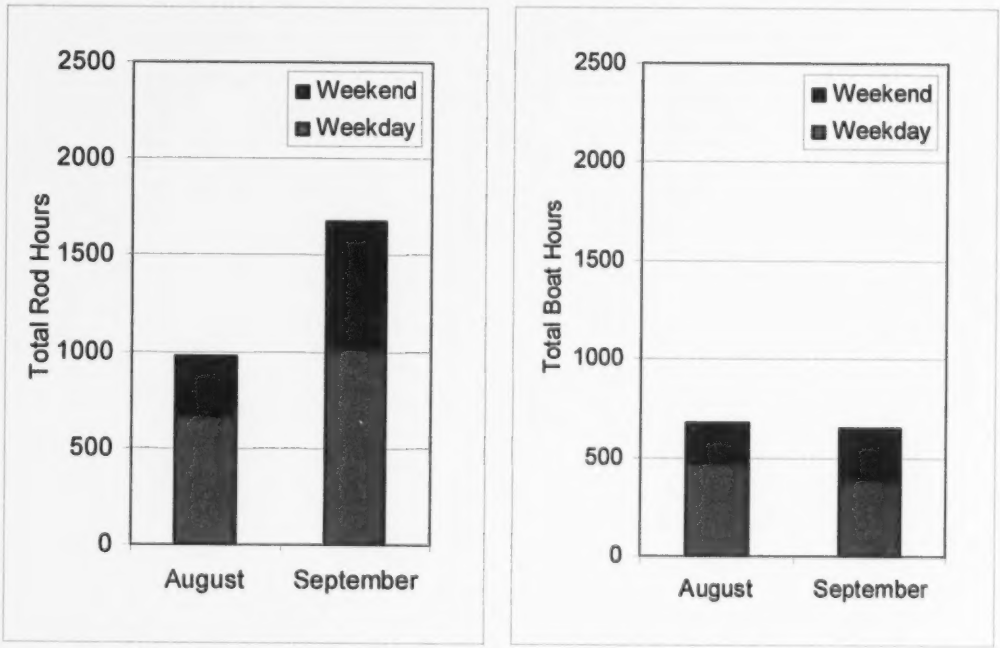


Figure 11: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type in 2009

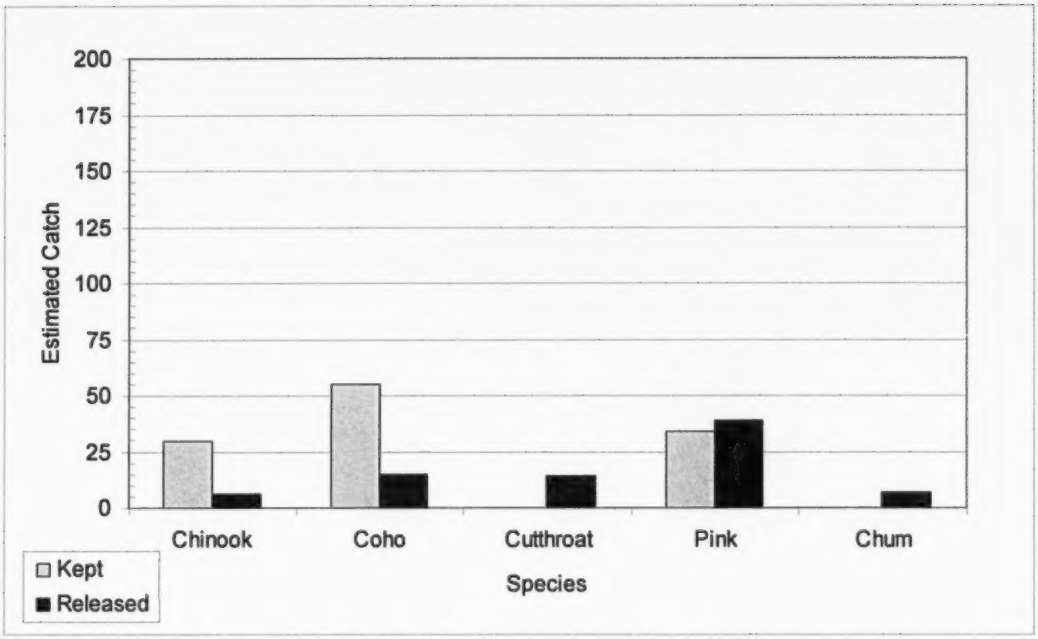


Figure 12: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho, sea-run Cutthroat Trout, Pink and Chum for the 2009 survey period

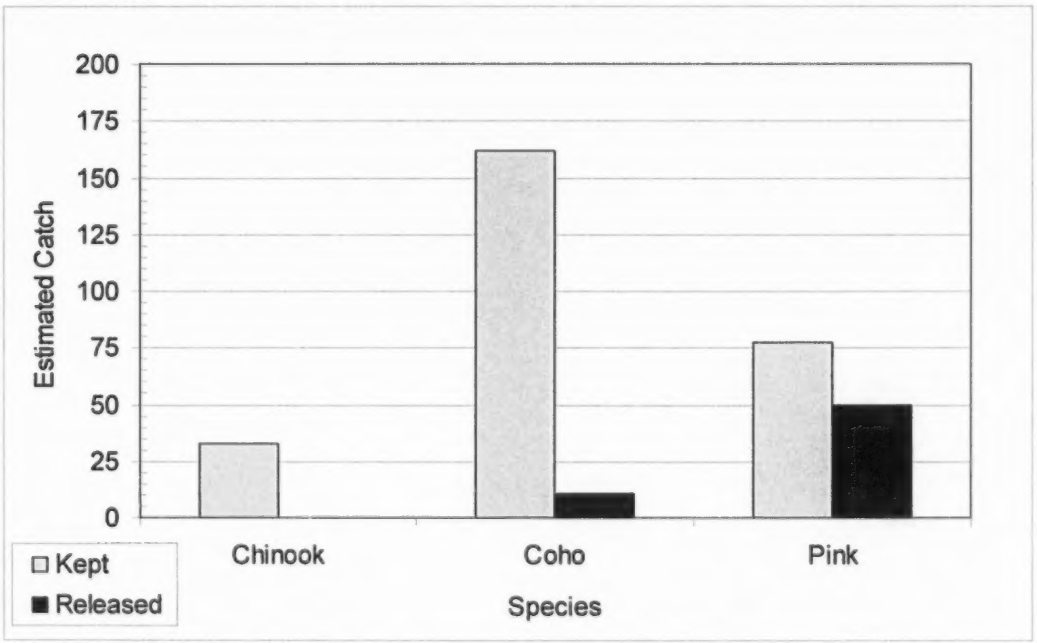


Figure 13: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and Pink salmon for the 2009 survey period

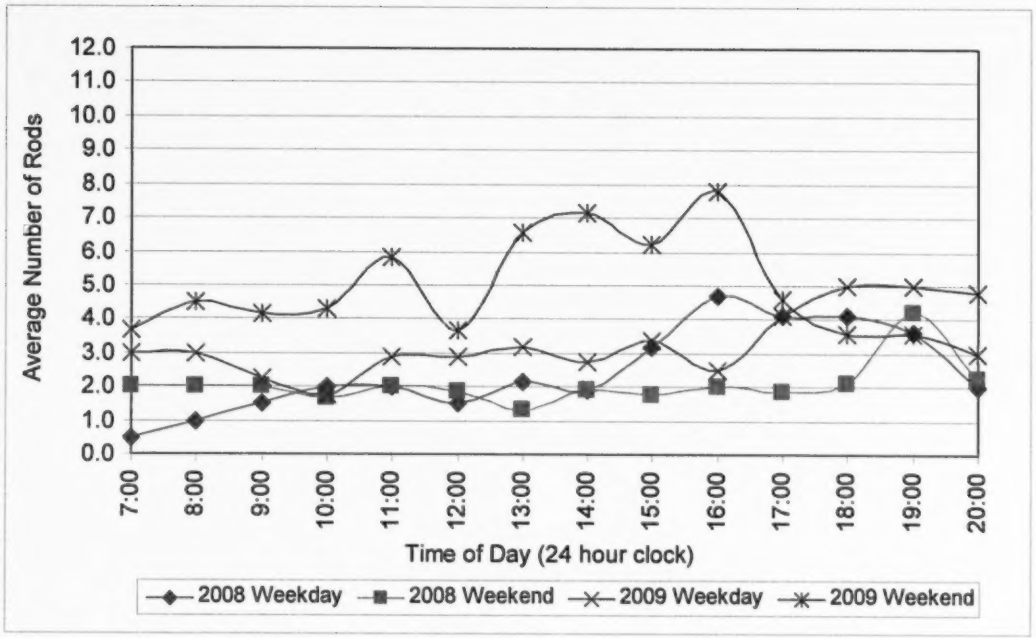


Figure 14: Average daily effort profile for beach-based anglers by stratum for 2008 and 2009 comparison

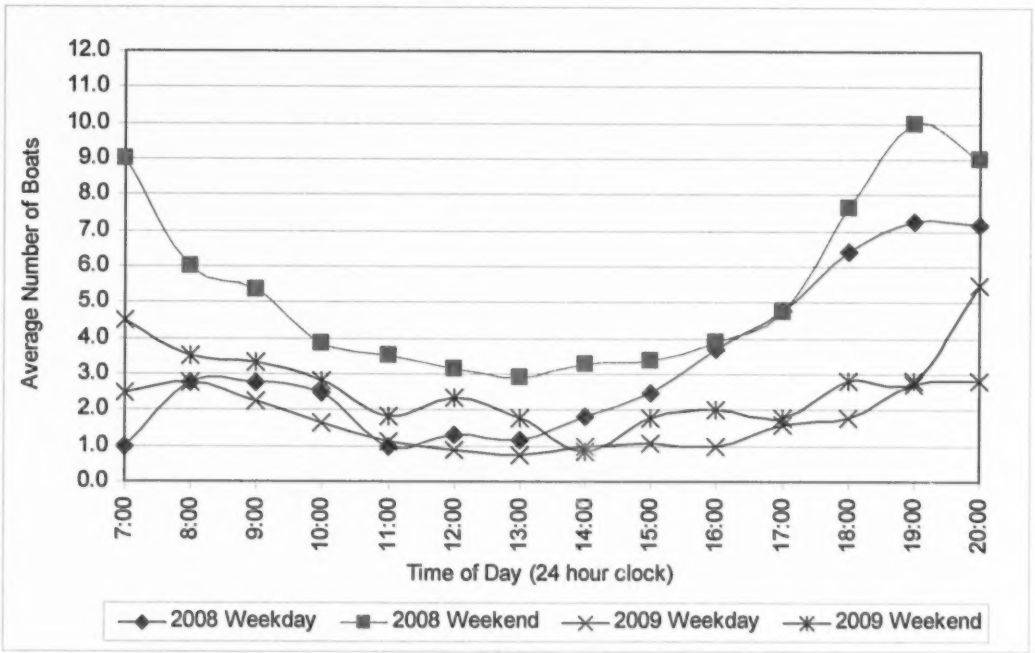


Figure 15: Average daily effort profile for boat-based anglers by stratum for 2008 and 2009 comparison

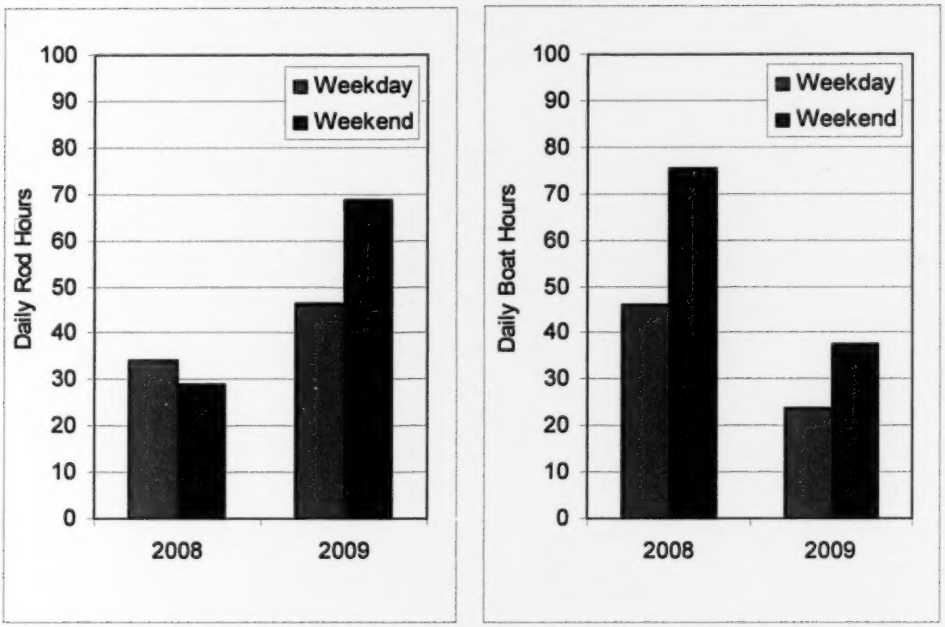


Figure 16: Average daily effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008 and 2009 comparison

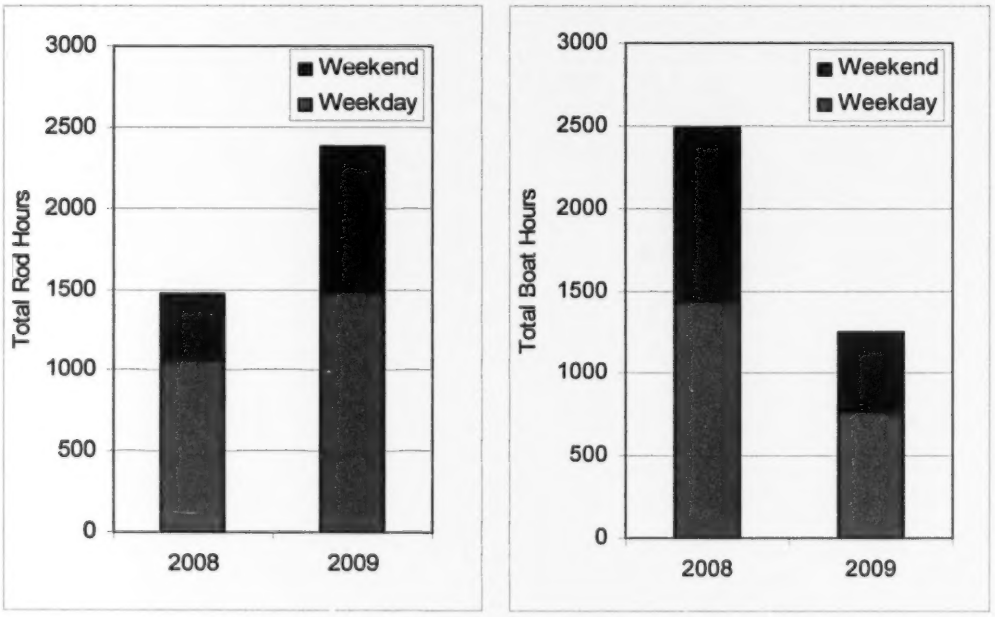


Figure 17: Total effort for beach-based anglers (rod hours; left) and boat-based anglers (boat hours; right) for each stratum by day type for 2008 and 2009 comparison

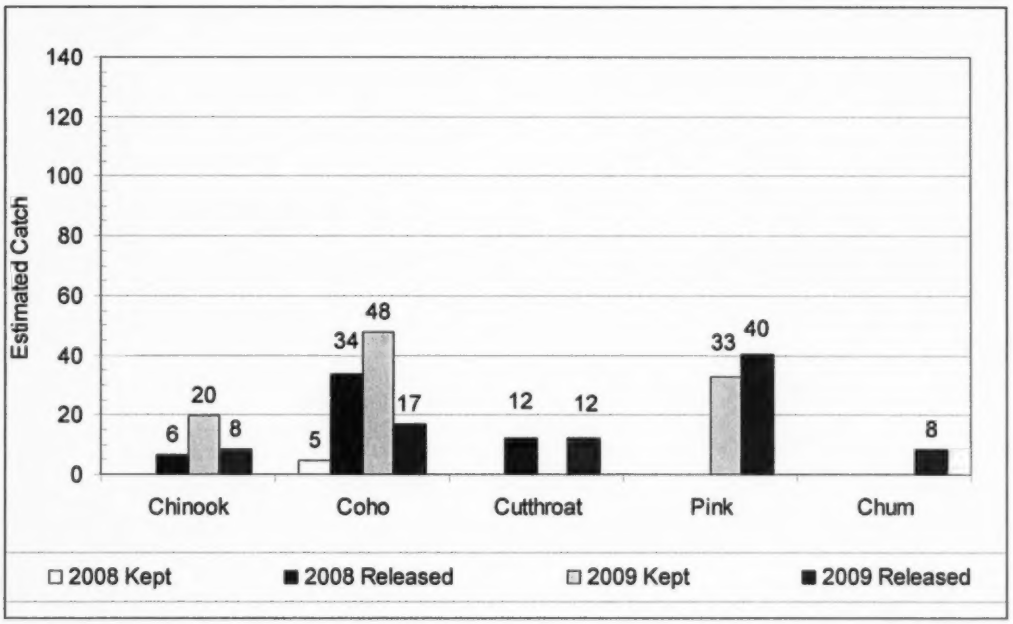


Figure 18: Total estimated catch for beach-based anglers (kept and released) for Chinook, Coho, sea-run Cutthroat Trout, Pink and Chum for the 2008 and 2009 survey period comparison

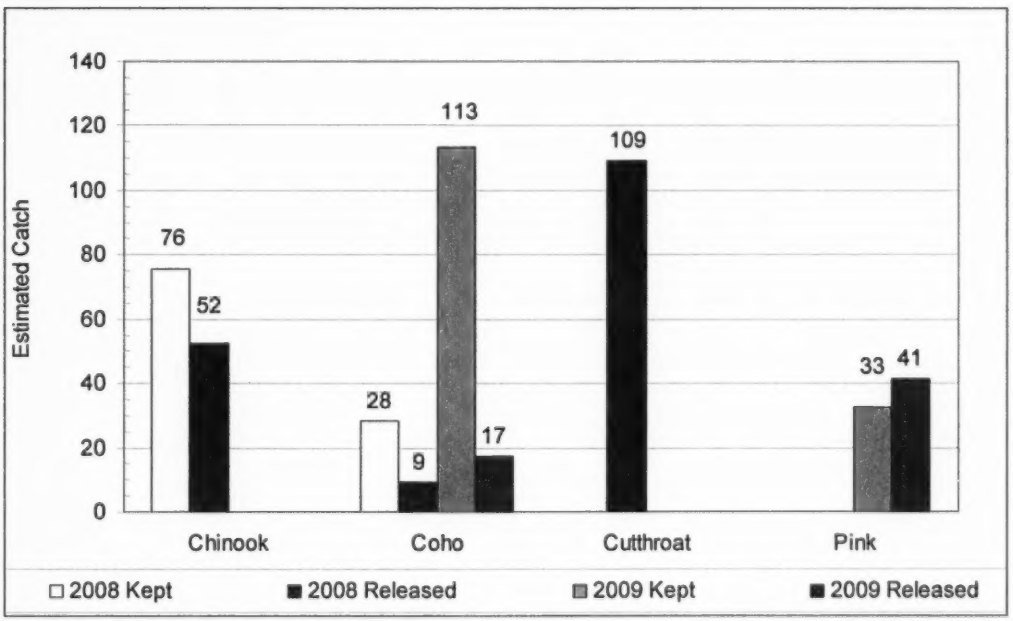


Figure 19: Total estimated catch for boat-based anglers (kept and released) for Chinook, Coho and sea-run Cutthroat Trout and Pink for the 2008 and 2009 survey period comparison

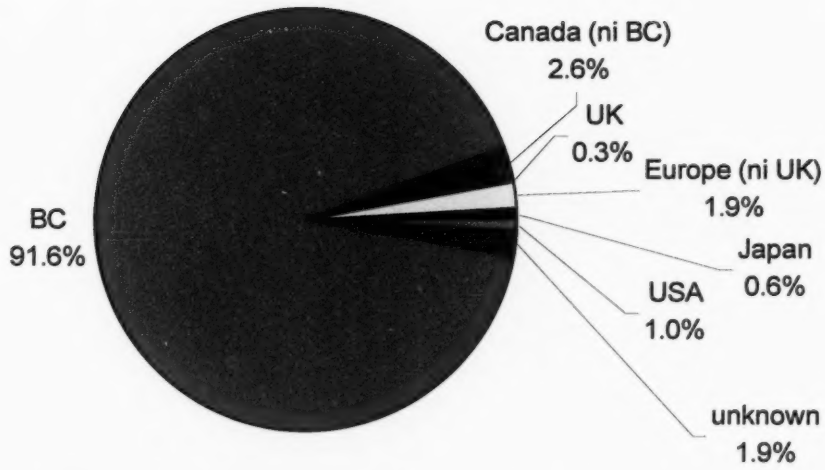


Figure 20: Residency of anglers fishing on the Lang Creek beach fishery during the 2008 survey period (n=308) where "ni" stands for "not including"

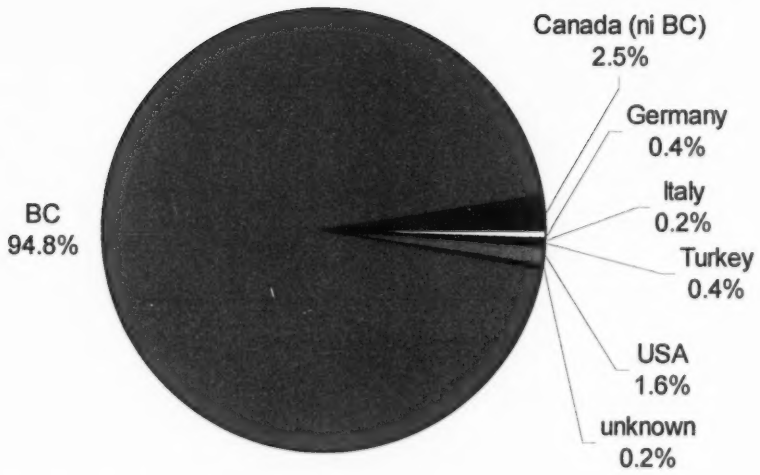


Figure 21: Residency of anglers fishing on the Lang Creek beach fishery during the 2009 survey period (n=562) where "ni" stands for "not including"

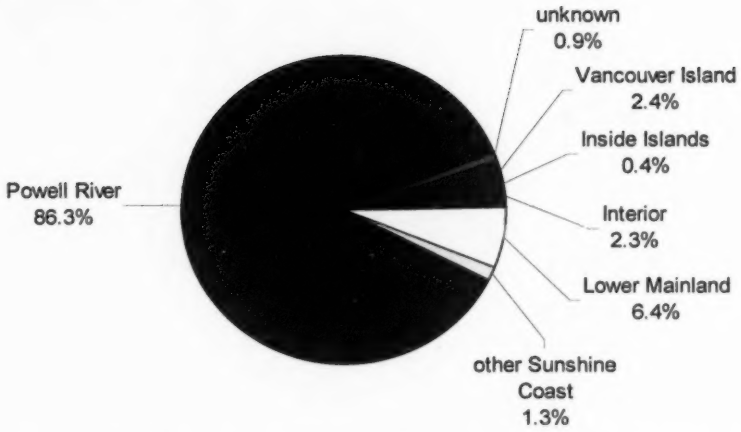


Figure 22: Regional residency within BC of anglers fishing at the Lang Creek beach fishery during the 2009 survey period (n=544)

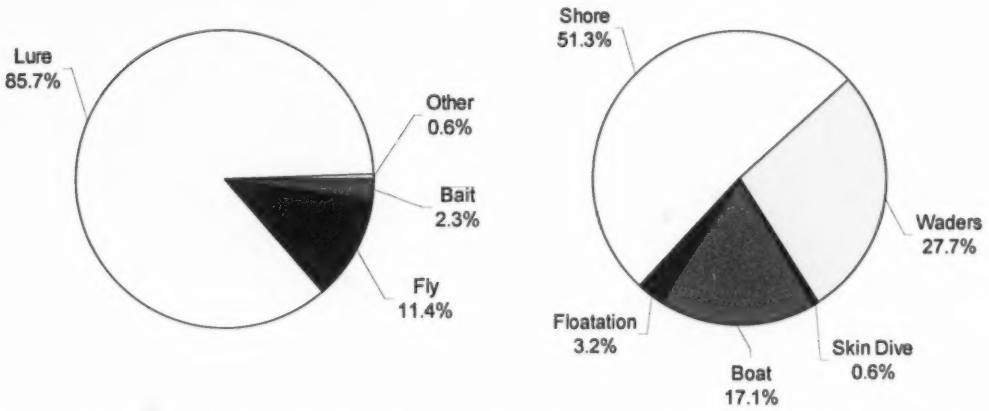


Figure 23: Percent of total of each type of angler gear (left) and fishing method (right) in the Lang Creek beach fishery for the 2008 survey period (n=308)

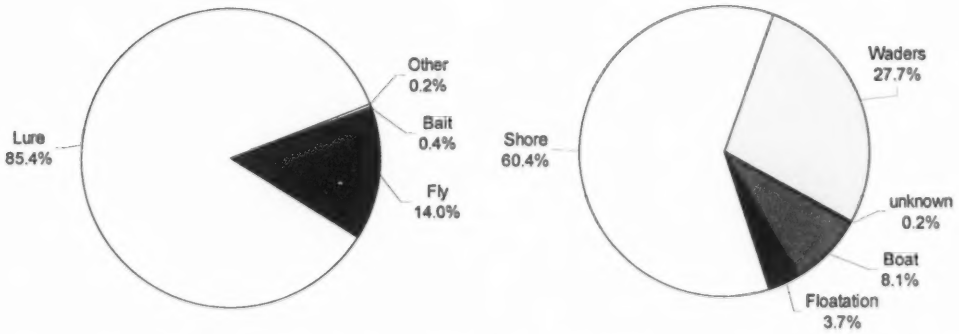


Figure 24: Percent of total of each type of angler gear (left) and fishing method (right) in the Lang Creek beach fishery for the 2009 survey period (n=570)

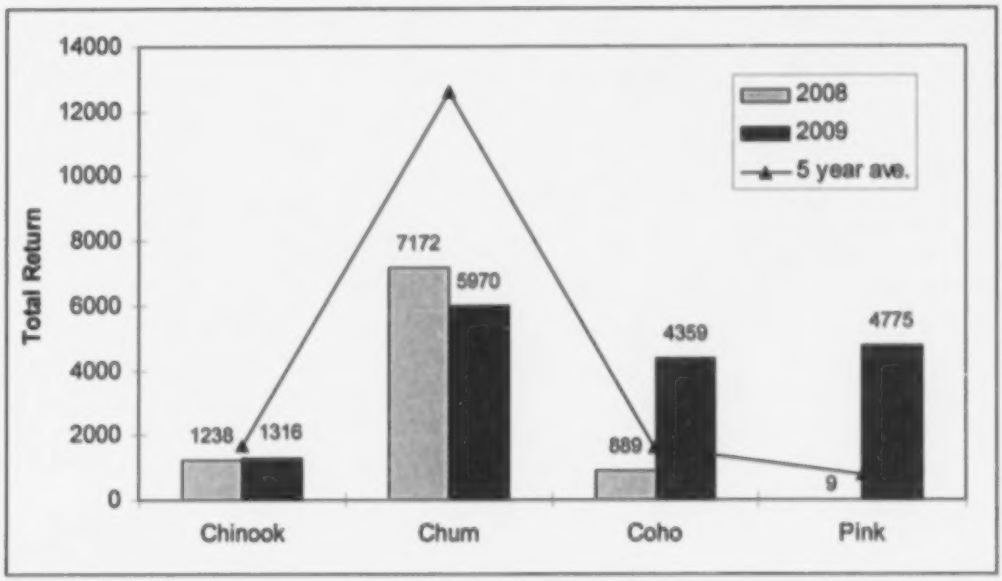


Figure 25: Lang Creek salmon escapement totals for 2008 and 2009 and previous five year averages (2003 – 2007 average)

Appendix A: Example of Daily Summary Form for Effort Counts

Lang Creek Selective Marked Fishery Daily Summary

Observer:	

Date (dd/mm/yyyy)	

Fishing Conditions:	Calm/Ripple	1
	Choppy	2
	Whitecaps	3
	Lg Swells	4

Shift Times (24hr)			
Start:		End:	

From	To	Time Block	Fishing Conditions	Count of Anglers Area A	Count of Anglers Area B	Count of Anglers Area C	Count of Anglers Area D	Count of Boats Launched from Beach	Total Anglers Counted in Leached Boats	Total Count of Boats Fishing	
Before 7:00		1									1
7:00	7:59	2									2
8:00	8:59	3									3
9:00	9:59	4									4
10:00	10:59	5									5
11:00	11:59	6									6
12:00	12:59	7									7
13:00	13:59	8									8
14:00	14:59	9									9
15:00	15:59	10									10
16:00	16:59	11									11
17:00	17:59	12									12
18:00	18:59	13									13
19:00	19:59	14									14
20:00	20:59	15									15
21:00 Plus		16									16

Comments: _____

Appendix B: Example of Interview Form for Angler and Catch Data

2008 Lang Creek Selective Marked Fishery Interview Form

Summary Information

Interview #: _____
(Please start each day with interview #1)

Date: _____ Observer: _____
(dd/mm/yyy)

Time Block: _____
(ie. 7 for interviews from 1200 to 1259 hrs)

Location: _____
(Section A, B, C, or D)

Water Conditions: _____
(1 - calm, 2 - choppy, 3 - rough, 4 - very rough)

Weather: _____
(1 - sunny, 2 - cloudy, 3 - raining, 4 - windy)

Angler Information

Angler Residence: _____ (ie. BC, AB, ON, Japan, Germany)

Fisher Start Time: _____ (Time ie. 1300 hrs)	Interview Time: _____ Use 24 hr clock to the nearest 0.5 hrs	Hours Fished: _____ (* nearest 0.5 hrs)

How much longer do you intend to fish? _____

What one species are you focused on? _____

What type of gear are you using: (circle one)	BAIT	LURE	FLY	OTHER
Fishing Method: (circle one)	SHORE	FLOATATION	WADERS	BOAT

Catch Information

Please use multiple lines if you have a combination of ad clipped and non-clipped data for the same species
(Fill in totals of catch by species)

Species	Kept	Adipose Clip (Y/N)	Released	Adipose Clip (Y/N)

Biosampling Information

Species	Length (mm)	Sex	Scale Book	Scale #'s	Adipose Clip (Y/N)	Head Tag #

Comments: